

**Supplemental Information
for
NASA/TM—2011–216470**

**Generalized Fluid System Simulation Program,
Version 5.0—Educational**

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APPENDIX D—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 1

Simulation of a Flow System Consisting of a Pump, Valve, and Pipe Line

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```

GFSSP VERSION
503
GFSSP INSTALLATION PATH
C:\Program Files\GFSSP\
ANALYST
ALOK MAJUMDAR
INPUT DATA FILE NAME
C:\Program Files\GFSSP\Examples\Ex1\Ex1.dat
OUTPUT FILE NAME
Ex1.out
TITLE
Simulation of a Flow System Consisting of a Pump, Valve and Pipe Line
USETUP
F
DENCON      GRAVITY    ENERGY    MIXTURE      THRUST      STEADY      TRANSV      SAVER
F           T          T          F           F           T          F          F
HEX         HCOEF      REACTING   INERTIA      CONDX      ADDPROP     PRINTI     ROTATION
F           F          F          F           F           F          T          F
BUOYANCY    HRATE      INVAL     MSORCE      MOVBNB     TPA        VARGEO     TVM
F           T          F          F           F           F          F          F
SHEAR       PRNTIN     PRNTADD   OPVALVE     TRANSQ     CONJUG      RADIAT     WINPLOT
F           T          T          F           F           F          F          T
PRESS       INSUC     VARROT    CYCLIC      CHKVALS    WINFILE     DALTON
F           F          F          F           F           T          F
NORMAL      SIMUL     SECONDL   NRSOLVT
F           T          T          F
NNODES      NINT      NBR       NF
4           2          3         1
RELAXK      RELAXD     RELAXH    CC           NITER
1           0.5      1         0.0001      500
NFLUID(I), I = 1, NF
11
NODE        INDEX    DESCRIPTION
1           2        "Node 1"
2           1        "Node 2"
3           1        "Node 3"
4           2        "Node 4"
NODE        PRES  (PSI)    TEMP (DEGF)    MASS SOURC    HEAT SOURC    THRST AREA    CONCENTRATION
1           14.7      60          0              0              0
2           14.7      60          0              0              0
3           14.7      60          0              0              0
4           14.7      60          0              0              0
INODE       NUMBR    NAMEBR
2           2        12  23
3           2        23  34
BRANCH      UPNODE    DNNODE    OPTION    DESCRIPTION
12          1        2         14       "Pump 12"
23          2        3         13       "Valve 23"
34          3        4         1        "Pipe 34"

BRANCH      OPTION -14    PUMP CONST1    PUMP CONST2    PUMP CONST3    AREA
12          -14       30888          0              -0.0008067     201.06
BRANCH      OPTION -13    DIA      K1      K2      AREA
23          -13       6        1000   0.1     28.274
BRANCH      OPTION -1    LENGTH    DIA      EPSD      ANGLE      AREA
34          -1       18000    6        0.005     95.74     28.274

```

.....
G F S S P (Version 5.0)
Generalized Fluid System Simulation Program
September, 2006
Developed by NASA/Marshall Space Flight Center
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A generalized computer program to calculate flow
rates, pressures, temperatures, and concentrations
in a flow network.
.....

TITLE :Simulation of a Flow System Consisting of a Pump, Valve and Pipe Line
ANALYST :ALOK MAJUMDAR
FILEIN :C:\Program Files\GFSSP\Examples\Ex1\Ex1.dat
FILEOUT :Ex1.out

LOGICAL VARIABLES

DENCON = F
GRAVITY = T
ENERGY = T
MIXTURE = F
THRUST = F
STEADY = T
TRANSV = F
SAVER = F
HEX = F
HCOEF = F
REACTING = F
INERTIA = F
CONDX = F
TWOD = F
PRINTI = T
ROTATION = F
BUOYANCY = F
HRATE = T
INVAL = F
MSORCE = F
MOVBND = F
TPA = F
VARGEO = F
TVM = F
SHEAR = F
PRNTIN = T
PRNTADD = T
ADDPROP = F
PRESS = F
INSUC = F
VARROT = F
NORMAL = F
SECONDL = T
CONJUG = F
NRSOLVT = F

NNODES = 4
NINT = 2
NBR = 3
NF = 1
NVAR = 5
NHREF = 2

FLUIDS: H2O

BOUNDARY NODES

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE	AREA (IN^2)	MASS (LBM/S)	HEAT (BTU/S)
2	0.0000E+00	0.0000E+00	0.0000E+00
3	0.0000E+00	0.0000E+00	0.0000E+00

BRANCH	UPNODE	DNNODE	OPTION
12	1	2	14
23	2	3	13
34	3	4	1

BRANCH	OPTION -14:	PUMP CONST1,	PUMP CONST2	PUMP CONST3	AREA
12	0.309E+05	0.000E+00	-0.807E-03	0.201E+03	

BRANCH	OPTION -13:	DIA, K1, K2, AREA
23	0.600E+01	0.100E+04 0.100E+00 0.283E+02

BRANCH	OPTION -1:	LENGTH, DIA, EPSD, ANGLE, AREA
34	0.180E+05	0.600E+01 0.500E-02 0.957E+02 0.283E+02

INITIAL GUESS FOR INTERNAL NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
2	0.1470E+02	0.6000E+02	0.7616E-03	0.6237E+02	0.0000E+00
3	0.1470E+02	0.6000E+02	0.7616E-03	0.6237E+02	0.0000E+00

TRIAL SOLUTION

BRANCH	DELP (PSI)	FLOWRATE (LBM/SEC)
12	0.0000	0.0100
23	0.0000	0.0100
34	0.0000	0.0100

SOLUTION

INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.2290E+03	0.6003E+02	0.1186E-01	0.6241E+02	0.0000E+00	0.0000E+00
3	0.2288E+03	0.6003E+02	0.1185E-01	0.6241E+02	0.0000E+00	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
2	0.2869E+02	0.5542E-01	0.7542E-03	0.9523E-04	0.1000E+01	0.1003E+01
3	0.2869E+02	0.5542E-01	0.7542E-03	0.9523E-04	0.1000E+01	0.1003E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/(LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.000E+00	-0.214E+03	0.191E+03	0.219E+01	0.241E+06	0.183E-02	0.000E+00	0.000E+00
23	0.764E-03	0.193E+00	0.191E+03	0.156E+02	0.644E+06	0.130E-01	0.210E-03	0.848E+02
34	0.591E+00	0.214E+03	0.191E+03	0.156E+02	0.644E+06	0.130E-01	0.162E+00	0.657E+05

***** TOTAL ENTROPY GENERATION = 0.163E+00 BTU/(R-SEC) *****

**** TOTAL WORK LOST = 0.120E+03 HP ****

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 5 ITERATIONS

TAU = 100000000.000000 ISTEP = 1

TIME OF ANALYSIS WAS 1.001440000000000E-002 SECS



APPENDIX E—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 2

Simulation of a Water Distribution Network

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```

GFSSP VERSION
503
GFSSP INSTALLATION PATH
C:\Program Files\GFSSP\
ANALYST
Alok Majumdar
INPUT DATA FILE NAME
C:\Program Files\GFSSP\Examples\Ex2\Ex2.dat
OUTPUT FILE NAME
Ex2.out
TITLE
Simulation of a water distribution network
USETUP
F
DENCON      GRAVITY    ENERGY    MIXTURE    THRUST     STEADY     TRANSV     SAVER
T           F          F          F          F          T          F          F
HEX         HCOEF      REACTING   INERTIA    CONDX      ADDPROP    PRINTI     ROTATION
F           F          F          F          F          F          T          F
BUOYANCY    HRATE      INVAL      MSORCE     MOVBNB     TPA        VARGEO     TVM
F           F          F          F          F          F          F          F
SHEAR       PRNTIN     PRNTADD    OPVALVE    TRANSQ     CONJUG     RADIAT     WINPLOT
F           T          T          F          F          F          F          T
PRESS       INSUC     VARROT     CYCLIC     CHKVALS    WINFILE    DALTON
F           F          F          F          F          T          F
NORMAL      SIMUL      SECONDL    NRSOLVT
F           T          T          F
NNODES      NINT       NBR        NF
9           5          10         0
RELAXK      RELAXD     RELAXH     CC          NITER
1           0.5        1          0.0001     500
RHOREF      EMUREF
62.4        0.00066
NODE        INDEX      DESCRIPTION
1           2          "Node 1"
2           1          "Node 2"
3           2          "Node 3"
4           2          "Node 4"
5           1          "Node 5"
6           1          "Node 6"
7           1          "Node 7"
8           1          "Node 8"
9           2          "Node 9"
NODE        PRES  (PSI)    MASS  SOURC    HEAT  SOURC    THRST  AREA
1           50          0          0          0          0
2           49.6        0          0          0          0
3           48          0          0          0          0
4           45          0          0          0          0
5           48.4        0          0          0          0
6           47.4        0          0          0          0
7           49.2        0          0          0          0
8           46.4        0          0          0          0
9           46          0          0          0          0
INODE       NUMBR      NAMEBR
2           3          12  25  27
5           4          25  53  57  56
6           3          56  68  64
7           3          27  57  78
8           3          78  68  89

```

BRANCH	UPNODE	DNNODE	OPTION	DESCRIPTION		
12	1	2	1	"Pipe 12"		
25	2	5	1	"Pipe 25"		
27	2	7	1	"Pipe 27"		
53	5	3	1	"Pipe 53"		
57	5	7	1	"Pipe 57"		
56	5	6	1	"Pipe 56"		
78	7	8	1	"Pipe 78"		
68	6	8	1	"Pipe 68"		
64	6	4	1	"Pipe 64"		
89	8	9	1	"Pipe 89"		
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE
12			120	6	0.0018	0
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE
25			2400	6	0.0018	0
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE
27			2400	5	0.0018	0
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE
53			120	5	0.0018	0
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE
57			1440	4	0.0018	0
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE
56			2400	4	0.0018	0
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE
78			2400	4	0.0018	0
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE
68			1440	4	0.0018	0
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE
64			120	4	0.0018	0
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE
89			120	5	0.0018	0
						AREA
						28.274
						AREA
						28.274
						AREA
						19.635
						AREA
						19.635
						AREA
						12.566
						AREA
						12.566
						AREA
						12.566
						AREA
						12.566
						AREA
						12.566
						AREA
						19.635

G F S S P (Version 5.0)
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 September, 2006
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A generalized computer program to calculate flow
 rates, pressures, temperatures and concentrations
 in a flow network.

TITLE :Simulation of a water distribution network
 ANALYST :Alok Majumdar
 FILEIN :C:\Program Files\GFSSP\Examples\Ex2\Ex2.dat
 FILEOUT :Ex2.out
 LOGICAL VARIABLES

3	0.4800E+02	0.0000E+00
4	0.4500E+02	0.0000E+00
9	0.4600E+02	0.0000E+00

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE	AREA (IN^2)	MASS (LBM/S)	HEAT BTU/LBM)
2	0.0000E+00	0.0000E+00	0.0000E+00
5	0.0000E+00	0.0000E+00	0.0000E+00
6	0.0000E+00	0.0000E+00	0.0000E+00
7	0.0000E+00	0.0000E+00	0.0000E+00
8	0.0000E+00	0.0000E+00	0.0000E+00

BRANCH	UPNODE	DNNODE	OPTION
12	1	2	1
25	2	5	1
27	2	7	1
53	5	3	1
57	5	7	1
56	5	6	1
78	7	8	1
68	6	8	1
64	6	4	1
89	8	9	1

BRANCH	OPTION-1:	LENGTH	DIA	EPSD	ANGLE	AREA
12		0.120E+03	0.600E+01	0.180E-02	0.000E+00	0.283E+02
25		0.240E+04	0.600E+01	0.180E-02	0.000E+00	0.283E+02
27		0.240E+04	0.500E+01	0.180E-02	0.000E+00	0.196E+02
53		0.120E+03	0.500E+01	0.180E-02	0.000E+00	0.196E+02
57		0.144E+04	0.400E+01	0.180E-02	0.000E+00	0.126E+02
56		0.240E+04	0.400E+01	0.180E-02	0.000E+00	0.126E+02
78		0.240E+04	0.400E+01	0.180E-02	0.000E+00	0.126E+02
68		0.144E+04	0.400E+01	0.180E-02	0.000E+00	0.126E+02
64		0.120E+03	0.400E+01	0.180E-02	0.000E+00	0.126E+02
89		0.120E+03	0.500E+01	0.180E-02	0.000E+00	0.196E+02

INITIAL GUESS FOR INTERNAL NODES

NODE	P (PSI)
2	0.4960E+02
5	0.4840E+02
6	0.4740E+02
7	0.4920E+02
8	0.4640E+02

```

TRIAL SOLUTION
BRANCH      DELP (PSI)      FLOWRATE (LBM/SEC)
12           0.0000          0.0100
25           0.0000          0.0100
27           0.0000          0.0100
53           0.0000          0.0100
57           0.0000          0.0100
56           0.0000          0.0100
78           0.0000          0.0100
68           0.0000          0.0100
64           0.0000          0.0100
89           0.0000          0.0100

```

```

SOLUTION
INTERNAL NODES
NODE        P (PSI)          EM (LBM)
2           0.4979E+02      0.0000E+00
5           0.4810E+02      0.0000E+00
6           0.4535E+02      0.0000E+00
7           0.4833E+02      0.0000E+00
8           0.4600E+02      0.0000E+00

```

```

BRANCHES
BRANCH      KFACTOR          DELP          FLOW RATE      VELOCITY      REYN. NO.      MACH NO.      ENTROPY GEN.      LOST WORK
              (LBF-S^2/      (PSI)          (LBM/SEC)      (FT/SEC)
              (LBM-FT) ^2)
12          0.301E-02      0.210E+00      0.100E+03      0.817E+01      0.386E+06      0.000E+00      0.135E-03      0.484E+02
25          0.609E-01      0.169E+01      0.631E+02      0.515E+01      0.244E+06      0.000E+00      0.687E-03      0.246E+03
27          0.154E+00      0.146E+01      0.370E+02      0.435E+01      0.171E+06      0.000E+00      0.349E-03      0.125E+03
53          0.762E-02      0.104E+00      0.444E+02      0.522E+01      0.206E+06      0.000E+00      0.300E-04      0.107E+02
57          0.301E+00      -0.224E+00      -0.104E+02      -0.190E+01      0.599E+05      0.000E+00      0.150E-04      0.536E+01
56          0.469E+00      0.275E+01      0.291E+02      0.534E+01      0.168E+06      0.000E+00      0.516E-03      0.184E+03
78          0.471E+00      0.232E+01      0.267E+02      0.490E+01      0.154E+06      0.000E+00      0.400E-03      0.143E+03
68          0.289E+00      -0.650E+00      -0.180E+02      -0.331E+01      0.104E+06      0.000E+00      0.755E-04      0.270E+02
64          0.230E-01      0.355E+00      0.471E+02      0.864E+01      0.272E+06      0.000E+00      0.108E-03      0.385E+02
89          0.858E-02      0.447E-02      0.866E+01      0.102E+01      0.401E+05      0.000E+00      0.249E-06      0.892E-01

```

***** TOTAL ENTROPY GENERATION = 0.232E-02 BTU/(R-SEC) *****

**** TOTAL WORK LOST = 0.151E+01 HP ****

```

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 11 ITERATIONS
TAU = 100000000.000000 ISTEP = 1

```

```

.....
TIME OF ANALYSIS WAS 2.002880000000000E-002 SECS
.....

```



APPENDIX F—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 3

Simulation of Compressible Flow in a Converging-Diverging Nozzle

<u>Contents</u>	<u>Page</u>
Example 3 Input File	10
Example 3 Output File	16

```

GFSSP VERSION
503
GFSSP INSTALLATION PATH
C:\Program Files\GFSSP\
ANALYST
jwb
INPUT DATA FILE NAME
C:\Program Files\GFSSP\Examples\Ex3\Ex3.dat
OUTPUT FILE NAME
Ex3.out
TITLE
Simulation of Compressible Flow in a Converging-Diverging Nozzle
USETUP
F
DENCON      GRAVITY      ENERGY      MIXTURE      THRUST      STEADY      TRANSV      SAVER
F            F            T            F            F            T            F            F
HEX          HCOEF        REACTING      INERTIA      CONDX        ADDPROP      PRINTI      ROTATION
F            F            F            T            F            F            F            F
BUOYANCY     HRATE          INVAL        MSORCE       MOVBNB      TPA          VARGEO      TVM
F            F            F            F            F            F            F            F
SHEAR        PRNTIN        PRNTADD      OPVALVE      TRANSQ      CONJUG       RADIAT      WINPLOT
F            F            F            F            F            F            F            T
PRESS        INSUC        VARROT       CYCLIC       CHKVALS     WINFILE      DALTON
F            F            F            F            F            T            F
NORMAL       SIMUL         SECONDL      NRSOLVT
F            T            T            F
NNODES      NINT          NBR          NF
17          15          16          1
RELAXK       RELAXD        RELAXH       CC            NITER
1            0.5        1            0.0001       500
NFLUID(I), I = 1, NF
11
NODE        INDEX      DESCRIPTION
1           2          "Node 1"
2           1          "Node 2"
3           1          "Node 3"
4           1          "Node 4"
5           1          "Node 5"
6           1          "Node 6"
7           1          "Node 7"
8           1          "Node 8"
9           1          "Node 9"
10          1          "Node 10"
11          1          "Node 11"
12          1          "Node 12"
13          1          "Node 13"
14          1          "Node 14"
15          1          "Node 15"
16          1          "Node 16"
17          2          "Node 17"
NODE        PRES  (PSI)    TEMP (DEGF)    MASS SOURC    HEAT SOURC    THRST AREA    CONCENTRATION
1           150          1000          0              0              0
2           14.7         60            0              0              0
3           14.7         60            0              0              0
4           14.7         60            0              0              0
5           14.7         60            0              0              0
6           14.7         60            0              0              0
7           14.7         60            0              0              0
8           14.7         60            0              0              0
9           14.7         60            0              0              0
10          14.7         60            0              0              0
11          14.7         60            0              0              0
12          14.7         60            0              0              0
13          14.7         60            0              0              0
14          14.7         60            0              0              0
15          14.7         60            0              0              0
16          14.7         60            0              0              0
17          60           1000          0              0              0

```

INODE	NUMBR	NAMEBR		
2	2	12	23	
3	2	23	34	
4	2	34	45	
5	2	45	56	
6	2	56	67	
7	2	67	78	
8	2	78	89	
9	2	89	910	
10	2	910	1011	
11	2	1011	1112	
12	2	1112	1213	
13	2	1213	1314	
14	2	1314	1415	
15	2	1415	1516	
16	2	1516	1617	

BRANCH	UPNODE	DNNODE	OPTION	DESCRIPTION
12	1	2	2	"Restrict 12"
23	2	3	2	"Restrict 23"
34	3	4	2	"Restrict 34"
45	4	5	2	"Restrict 45"
56	5	6	2	"Restrict 56"
67	6	7	2	"Restrict 67"
78	7	8	2	"Restrict 78"
89	8	9	2	"Restrict 89"
910	9	10	2	"Restrict 910"
1011	10	11	2	"Restrict 1011"
1112	11	12	2	"Restrict 1112"
1213	12	13	2	"Restrict 1213"
1314	13	14	2	"Restrict 1314"
1415	14	15	2	"Restrict 1415"
1516	15	16	2	"Restrict 1516"
1617	16	17	2	"Restrict 1617"

BRANCH	OPTION	-2	FLOW	COEFF	AREA
12			0		0.3587
BRANCH	OPTION	-2	FLOW	COEFF	AREA
23			0		0.2717
BRANCH	OPTION	-2	FLOW	COEFF	AREA
34			0		0.2243
BRANCH	OPTION	-2	FLOW	COEFF	AREA
45			0		0.2083
BRANCH	OPTION	-2	FLOW	COEFF	AREA
56			0		0.1901
BRANCH	OPTION	-2	FLOW	COEFF	AREA
67			0		0.1949
BRANCH	OPTION	-2	FLOW	COEFF	AREA
78			0		0.2255
BRANCH	OPTION	-2	FLOW	COEFF	AREA
89			0		0.2875
BRANCH	OPTION	-2	FLOW	COEFF	AREA
910			0		0.3948
BRANCH	OPTION	-2	FLOW	COEFF	AREA
1011			0		0.564
BRANCH	OPTION	-2	FLOW	COEFF	AREA
1112			0		0.7633
BRANCH	OPTION	-2	FLOW	COEFF	AREA
1213			0		0.9927
BRANCH	OPTION	-2	FLOW	COEFF	AREA
1314			0		1.252
BRANCH	OPTION	-2	FLOW	COEFF	AREA
1415			0		1.4668
BRANCH	OPTION	-2	FLOW	COEFF	AREA
1516			0		1.5703
BRANCH	OPTION	-2	FLOW	COEFF	AREA
1617			0		1.6286

BRANCH	NOUBR	NMUBR
12	0	
23	1	12
34	1	23
45	1	34
56	1	45
67	1	56
78	1	67
89	1	78
910	1	89
1011	1	910
1112	1	1011
1213	1	1112
1314	1	1213
1415	1	1314
1516	1	1415
1617	1	1516

BRANCH	NODBR	NMDBR
12	1	23
23	1	34
34	1	45
45	1	56
56	1	67
67	1	78
78	1	89
89	1	910
910	1	1011
1011	1	1112
1112	1	1213
1213	1	1314
1314	1	1415
1415	1	1516
1516	1	1617
1617	0	

BRANCH		
12		
UPSTRM BR.	ANGLE	
DNSTRM BR.	ANGLE	
23	0.00000	

BRANCH		
23		
UPSTRM BR.	ANGLE	
12	0.00000	
DNSTRM BR.	ANGLE	
34	0.00000	

BRANCH		
34		
UPSTRM BR.	ANGLE	
23	0.00000	
DNSTRM BR.	ANGLE	
45	0.00000	

BRANCH		
45		
UPSTRM BR.	ANGLE	
34	0.00000	
DNSTRM BR.	ANGLE	
56	0.00000	

BRANCH		
56		
UPSTRM BR.	ANGLE	
45	0.00000	
DNSTRM BR.	ANGLE	
67	0.00000	

BRANCH		
67		
UPSTRM BR.	ANGLE	
56	0.00000	
DNSTRM BR.	ANGLE	
78	0.00000	

BRANCH		
78		

UPSTRM BR.	ANGLE
67	0.00000
DNSTRM BR.	ANGLE
89	0.00000
BRANCH	
89	
UPSTRM BR.	ANGLE
78	0.00000
DNSTRM BR.	ANGLE
910	0.00000
BRANCH	
910	
UPSTRM BR.	ANGLE
89	0.00000
DNSTRM BR.	ANGLE
1011	0.00000
BRANCH	
1011	
UPSTRM BR.	ANGLE
910	0.00000
DNSTRM BR.	ANGLE
1112	0.00000
BRANCH	
1112	
UPSTRM BR.	ANGLE
1011	0.00000
DNSTRM BR.	ANGLE
1213	0.00000
BRANCH	
1213	
UPSTRM BR.	ANGLE
1112	0.00000
DNSTRM BR.	ANGLE
1314	0.00000
BRANCH	
1314	
UPSTRM BR.	ANGLE
1213	0.00000
DNSTRM BR.	ANGLE
1415	0.00000
BRANCH	
1415	
UPSTRM BR.	ANGLE
1314	0.00000
DNSTRM BR.	ANGLE
1516	0.00000
BRANCH	
1516	
UPSTRM BR.	ANGLE
1415	0.00000
DNSTRM BR.	ANGLE
1617	0.00000
BRANCH	
1617	
UPSTRM BR.	ANGLE
1516	0.00000
DNSTRM BR.	ANGLE

NUMBER OF BRANCHES WITH INERTIA

16
12
23
34
45
56
67
78
89
910
1011
1112
1213
1314
1415
1516
1617

.....

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 Generalized Fluid System Simulation Program
 September, 2006
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A generalized computer program to calculate flow
 rates, pressures, temperatures and concentrations
 in a flow network.

.....

TITLE :Simulation of Compressible Flow in a Converging-Diverging Nozzle
 ANALYST :jwb
 FILEIN :C:\Program Files\GFSSP\Examples\Ex3\Ex3.dat
 FILEOUT :Ex3.out
 LOGICAL VARIABLES
 DENCON = F
 GRAVITY = F
 ENERGY = T
 MIXTURE = F
 THRUST = F
 STEADY = T
 TRANSV = F
 SAVER = F
 HEX = F
 HCOEF = F
 REACTING = F
 INERTIA = T
 CONDX = F
 TWOD = F
 PRINTI = F
 ROTATION = F
 BUOYANCY = F
 HRATE = F
 INVALID = F
 MSORCE = F
 MOVBNB = F
 TPA = F
 VARGEO = F
 TVM = F
 SHEAR = F
 PRNTIN = F
 PRNTADD = F
 ADDPROP = F
 PRESS = F
 INSUC = F
 VARROT = F
 NORMAL = F
 SECONDL = T
 CONJUG = F
 NRSOLVT = F

 NNODES = 17
 NINT = 15
 NBR = 16
 NF = 1
 NVAR = 31
 NHREF = 2

FLUIDS: H2O

BOUNDARY NODES				
NODE	P (PSI)	T (F)	RHO (LBM/FT^3)	AREA (IN^2)
1	0.1500E+03	0.1000E+04	0.1736E+00	0.0000E+00
17	0.6000E+02	0.1000E+04	0.6919E-01	0.0000E+00

SOLUTION

INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.1500E+03	0.1000E+04	0.9939E+00	0.1736E+00	0.0000E+00	0.1000E+01
3	0.1373E+03	0.9725E+03	0.9939E+00	0.1620E+00	0.0000E+00	0.1000E+01
4	0.1197E+03	0.9305E+03	0.9941E+00	0.1455E+00	0.0000E+00	0.1000E+01
5	0.1045E+03	0.8897E+03	0.9942E+00	0.1308E+00	0.0000E+00	0.1000E+01
6	0.8213E+02	0.8199E+03	0.9944E+00	0.1084E+00	0.0000E+00	0.1000E+01
7	0.5974E+02	0.7321E+03	0.9946E+00	0.8463E-01	0.0000E+00	0.1000E+01
8	0.4267E+02	0.6445E+03	0.9948E+00	0.6523E-01	0.0000E+00	0.1000E+01
9	0.3498E+02	0.5953E+03	0.9949E+00	0.5597E-01	0.0000E+00	0.1000E+01
10	0.4116E+02	0.6354E+03	0.9949E+00	0.6344E-01	0.0000E+00	0.1000E+01
11	0.5165E+02	0.6935E+03	0.9947E+00	0.7561E-01	0.0000E+00	0.1000E+01
12	0.5650E+02	0.7172E+03	0.9946E+00	0.8106E-01	0.0000E+00	0.1000E+01
13	0.5839E+02	0.7260E+03	0.9946E+00	0.8315E-01	0.0000E+00	0.1000E+01
14	0.5930E+02	0.7301E+03	0.9946E+00	0.8415E-01	0.0000E+00	0.1000E+01
15	0.5974E+02	0.7321E+03	0.9946E+00	0.8463E-01	0.0000E+00	0.1000E+01
16	0.5991E+02	0.7328E+03	0.9946E+00	0.8483E-01	0.0000E+00	0.1000E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/ (LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.000E+00	0.000E+00	0.336E+00	0.778E+03	0.376E+06	0.342E+00	0.000E+00	0.000E+00
23	0.000E+00	0.127E+02	0.336E+00	0.103E+04	0.432E+06	0.452E+00	0.000E+00	0.000E+00
34	0.000E+00	0.176E+02	0.336E+00	0.133E+04	0.485E+06	0.592E+00	0.000E+00	0.000E+00
45	0.000E+00	0.153E+02	0.336E+00	0.160E+04	0.520E+06	0.720E+00	0.000E+00	0.000E+00
56	0.000E+00	0.223E+02	0.336E+00	0.195E+04	0.563E+06	0.890E+00	0.000E+00	0.000E+00
67	0.000E+00	0.224E+02	0.336E+00	0.229E+04	0.591E+06	0.107E+01	0.000E+00	0.000E+00
78	0.000E+00	0.171E+02	0.336E+00	0.254E+04	0.595E+06	0.123E+01	0.000E+00	0.000E+00
89	0.000E+00	0.769E+01	0.336E+00	0.258E+04	0.576E+06	0.130E+01	0.000E+00	0.000E+00
910	0.000E+00	-0.618E+01	0.336E+00	0.219E+04	0.518E+06	0.112E+01	0.000E+00	0.000E+00
1011	0.000E+00	-0.105E+02	0.336E+00	0.135E+04	0.415E+06	0.682E+00	0.000E+00	0.000E+00
1112	0.000E+00	-0.485E+01	0.336E+00	0.840E+03	0.336E+06	0.413E+00	0.000E+00	0.000E+00
1213	0.000E+00	-0.189E+01	0.336E+00	0.602E+03	0.288E+06	0.293E+00	0.000E+00	0.000E+00
1314	0.000E+00	-0.903E+00	0.336E+00	0.465E+03	0.254E+06	0.226E+00	0.000E+00	0.000E+00
1415	0.000E+00	-0.443E+00	0.336E+00	0.393E+03	0.234E+06	0.190E+00	0.000E+00	0.000E+00
1516	0.000E+00	-0.174E+00	0.336E+00	0.365E+03	0.226E+06	0.177E+00	0.000E+00	0.000E+00
1617	0.000E+00	-0.857E-01	0.336E+00	0.351E+03	0.221E+06	0.170E+00	0.000E+00	0.000E+00

***** TOTAL ENTROPY GENERATION = 0.000E+00 BTU/(R-SEC) *****

**** TOTAL WORK LOST = 0.000E+00 HP *****

.....
TIME OF ANALYSIS WAS 0.300432000000000 SECS
.....



APPENDIX G—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 4

Simulation of the Mixing of Combustion Gases and a Cold Gas Stream

<u>Contents</u>	<u>Page</u>
Example 4 Input File	19
Example 4 Output File	20

```

GFSSP VERSION
503
GFSSP INSTALLATION PATH
C:\Program Files\GFSSP\
ANALYST
ALOK MAJUMDAR
INPUT DATA FILE NAME
C:\Program Files\GFSSP\Examples\Ex4\Ex4.dat
OUTPUT FILE NAME
Ex4.out
TITLE
Simulation of the Mixing of Combustion Gases and a Cold Gas Stream
USETUP
F
DENCON      GRAVITY    ENERGY    MIXTURE    THRUST     STEADY     TRANSV     SAVER
F           F          T          T          F          T          F          F
HEX         HCOEF      REACTING   INERTIA    CONDX      ADDPROP     PRINTI     ROTATION
F           F          F          F          F          F          T          F
BOUYANCY    HRATE      INVAL     MSORCE     MOVBNB     TPA         VARGEO     TVM
F           T          F          F          F          F          F          F
SHEAR       PRNTIN     PRNTADD   OPVALVE    TRANSQ     CONJUG      RADIAT     WINPLOT
F           T          T          F          F          F          F          T
PRESS       INSUC      VARROT    CYCLIC     CHKVALS    WINFILE     DALTON
F           F          F          F          F          T          F
NORMAL      SIMUL      SECONDL   NRSOLVT
F           F          T          F
NNODES      NINT       NBR       NF
4           1          3          2
RELAXK      RELAXD     RELAXH    CC          NITER
1           0.5       0.75      0.0001     500
NFLUID(I), I = 1, NF
6 11
NODE        INDEX      DESCRIPTION
1           2          "Node 1"
2           2          "Node 2"
3           1          "Node 3"
4           2          "Node 4"
NODE        PRES (PSI)    TEMP (DEGF)    MASS SOURC    HEAT SOURC    THRST AREA    CONCENTRATION
1           500         1500           0             0             0             0.1    0.9
2           500         80             0             0             0             1    0
3           338.2       1500           0             0             0             0.1    0.9
4           14.7        80             0             0             0             0.5    0.5
INODE       NUMBR      NAMEBR
3           3          13      23      34
BRANCH      UPNODE     DNNODE     OPTION     DESCRIPTION
13          1          3          2          "Restrict 13"
23          2          3          2          "Restrict 23"
34          3          4          22         "Orifice 34"
BRANCH      OPTION -2    FLOW COEFF    AREA
13          0.6         1
BRANCH      OPTION -2    FLOW COEFF    AREA
23          0.6         1
BRANCH      OPTION -22   AREA          FLOW COEF
34          1          0.6

```

```

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    Generalized Fluid System Simulation Program
      September, 2006
    Developed by NASA/Marshall Space Flight Center
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rates, pressures, temperatures and concentrations
in a flow network.
.....

```

```

TITLE      :Simulation of the Mixing of Combustion Gases and a Cold Gas Stream
ANALYST    :ALOK MAJUMDAR
FILEIN     :C:\Program Files\GFSSP\Examples\Ex4\Ex4.dat
FILEOUT    :Ex4.out
LOGICAL VARIABLES
DENCON     = F
GRAVITY    = F
ENERGY     = T
MIXTURE    = T
THRUST     = F
STEADY     = T
TRANSV     = F
SAVER      = F
HEX        = F
HCOEF      = F
REACTING   = F
INERTIA    = F
CONDX      = F
TWOD       = F
PRINTI     = T
ROTATION   = F
BUOYANCY   = F
HRATE      = T
INVAL      = F
MSORCE     = F
MOVBND     = F
TPA        = F
VARGEO     = F
TVM        = F
SHEAR      = F
PRNTIN     = T
PRNTADD    = T
ADDPROP    = F
PRESS      = F
INSUC      = F
VARROT     = F
NORMAL     = F
SECONDL    = T
CONJUG     = F
NRSOLVT    = F

NNODES     = 4
NINT       = 1
NBR        = 3
NF         = 2
NVAR       = 4
NHREF      = 2

```

FLUIDS: O2 H2O

BOUNDARY NODES

NODE	P (PSI)	T (F)	RHO (LBM/FT^3)	AREA (IN^2)	CONCENTRATIONS	
					O2	H2O
1	0.5000E+03	0.1500E+04	0.3931E+00	0.0000E+00	0.1000E+00	0.9000E+00
2	0.5000E+03	0.8000E+02	0.2819E+01	0.0000E+00	0.1000E+01	0.0000E+00
4	0.1470E+02	0.8000E+02	0.4725E+02	0.0000E+00	0.5000E+00	0.5000E+00

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE	AREA (IN^2)	MASS (LBM/S)	HEAT (BTU/S)
3	0.0000E+00	0.0000E+00	0.0000E+00

BRANCH	UPNODE	DNNODE	OPTION
13	1	3	2
23	2	3	2
34	3	4	22

BRANCH	OPTION-2	FLOW COEF	AREA
13		0.600E+00	0.100E+01
BRANCH	OPTION-2	FLOW COEF	AREA
23		0.600E+00	0.100E+01
BRANCH	OPTION-22	FLOW COEF	AREA
34		0.600E+00	0.100E+01

INITIAL GUESS FOR INTERNAL NODES

NODE	P (PSI)	TF (F)	Z (COMP) (LBM/FT^3)	RHO	CONCENTRATIONS	
					O2	H2O
3	0.3382E+03	0.1500E+04	0.9966E+00	0.2984E+00	0.1000E+00	0.9000E+00

TRIAL SOLUTION

BRANCH	DELP (PSI)	FLOWRATE (LBM/SEC)
13	0.0000	0.0100
23	0.0000	0.0100
34	0.0000	0.0100

SOLUTION

INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	CONCENTRATIONS	
						O2	H2O
3	0.4788E+03	0.6886E+03	0.9862E+00	0.1060E+01	0.0000E+00	0.7553E+00	0.2447

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
3	0.7213E+03	0.1527E+01	0.2079E-04	0.8153E-05	0.3757E+00	0.1297E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/ (LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
13	0.228E+04	0.212E+02	0.116E+01	0.424E+03	0.560E+06	0.166E+00	0.590E-02	0.900E+04
23	0.317E+03	0.212E+02	0.310E+01	0.158E+03	0.294E+07	0.143E+00	0.800E-02	0.336E+04
34	0.317E+03	0.464E+03	0.426E+01	0.579E+03	0.277E+07	0.336E+00	0.259E-01	0.232E+05

***** TOTAL ENTROPY GENERATION = 0.398E-01 BTU/(R-SEC) *****

**** TOTAL WORK LOST = 0.646E+02 HP ****

WARNING! CHKGASP: T out of fluid property range at node 1
WARNING! CHKGASP: T out of fluid property range at node 3

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 27 ITERATIONS
TAU = 100000000.000000 ISTEP = 1

TIME OF ANALYSIS WAS 2.002880000000000E-002 SECS



APPENDIX H—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 5

Simulation of a Flow System Involving a Heat Exchanger

Contents	Page
Example 5 Input File	23
Example 5 Output File	25

```

GFSSP VERSION
503
GFSSP INSTALLATION PATH
C:\Program Files\GFSSP\
ANALYST
Todd Steadman
INPUT DATA FILE NAME
C:\Program Files\GFSSP\Examples\Ex5\Ex5.dat
OUTPUT FILE NAME
Ex5.out
TITLE
Simulation of a Flow System Involving a Heat Exchanger
USETUP
F
DENCON      GRAVITY    ENERGY    MIXTURE    THRUST     STEADY     TRANSV     SAVER
F           F          T          F          F          T          F          F
HEX         HCOEF      REACTING   INERTIA    CONDX      ADDPROP    PRINTI     ROTATION
T           T          F          F          F          F          F          F
BUOYANCY    HRATE      INVAL     MSORCE     MOVBNB     TPA        VARGEO     TVM
F           T          F          F          F          F          F          F
SHEAR       PRNTIN     PRNTADD   OPVALVE    TRANSQ     CONJUG     RADIAT     WINPLOT
F           T          F          F          F          F          F          T
PRESS       INSUC      VARROT    CYCLIC     CHKVALS    WINFILE    DALTON
F           F          F          F          F          T          F
NORMAL      SIMUL      SECONDL   NRSOLVT
F           T          T          F
NNODES      NINT       NBR       NF
8           4          6          1
RELAXK      RELAXD     RELAXH    CC          NITER
1           0.5        1          0.0001      500
NFLUID(I), I = 1, NF
11
NODE        INDEX      DESCRIPTION
1           2          "Node 1"
2           1          "Node 2"
3           1          "Node 3"
4           2          "Node 4"
5           2          "Node 5"
6           1          "Node 6"
7           1          "Node 7"
8           2          "Node 8"
NODE        PRES (PSI)    TEMP (DEGF)    MASS SOURC    HEAT SOURC    THRST AREA    CONCENTRATION
1           50          100            0              0              0
2           14.7        60             0              0              0
3           14.7        60             0              0              0
4           25          60             0              0              0
5           50          60             0              0              0
6           14.7        60             0              0              0
7           14.7        60             0              0              0
8           25          60             0              0              0
INODE       NUMBR      NAMEBR
2           2          12      23
3           2          23      34
6           2          56      67
7           2          67      78
BRANCH      UPNODE     DNNODE     OPTION     DESCRIPTION
12          1          2          1          "Pipe 12"
23          2          3          1          "Pipe 23"
34          3          4          1          "Pipe 34"
56          5          6          1          "Pipe 56"
67          6          7          1          "Pipe 67"
78          7          8          1          "Pipe 78"
BRANCH      OPTION -1    LENGTH    DIA        EPSD        ANGLE        AREA
12          10          0.25      0          0           0.049087
BRANCH      OPTION -1    LENGTH    DIA        EPSD        ANGLE        AREA
23          10          0.25      0          0           0.049087
BRANCH      OPTION -1    LENGTH    DIA        EPSD        ANGLE        AREA
34          10          0.25      0          0           0.049087
BRANCH      OPTION -1    LENGTH    DIA        EPSD        ANGLE        AREA
56          10          0.5       0          0           0.19635
BRANCH      OPTION -1    LENGTH    DIA        EPSD        ANGLE        AREA

```


67		10	0.5	0	0	0.19635
BRANCH	OPTION -1	LENGTH	DIA	EPSD	ANGLE	AREA
78		10	0.5	0	0	0.19635
NUMBER OF HEAT EXCHANGERS						
1						
IBRHOT	IBRCLD	ITYPHX	ARHOT	ARCOLD	UA	HEXEFF
23	67	1	0	0	1.1038	1.5

.....

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in a flow network.

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TITLE :Simulation of a Flow System Involving a Heat Exchanger
ANALYST :Todd Steadman
FILEIN :C:\Program Files\GFSSP\Examples\Ex5\Ex5.dat
FILEOUT :Ex5.out
LOGICAL VARIABLES
DENCON = F
GRAVITY = F
ENERGY = T
MIXTURE = F
THRUST = F
STEADY = T
TRANSV = F
SAVER = F
HEX = T
HCOEF = T
REACTING = F
INERTIA = F
CONDX = F
TWOD = F
PRINTI = F
ROTATION = F
BUOYANCY = F
HRATE = T
INVAL = F
MSORCE = F
MOVBND = F
TPA = F
VARGEO = F
TVM = F
SHEAR = F
PRNTIN = T
PRNTADD = F
ADDPROP = F
PRESS = F
INSUC = F
VARROT = F
NORMAL = F
SECONDL = T
CONJUG = F
NRSOLVT = F

NNODES = 8
NINT = 4
NBR = 6
NF = 1
NVAR = 10
NHREF = 2

FLUIDS: H2O

BOUNDARY NODES

NODE	P	T	RHO	AREA
(PSI)	(F)	(LBM/FT^3)	(IN^2)	
1	0.5000E+02	0.1000E+03	0.6201E+02	0.0000E+00
4	0.2500E+02	0.6000E+02	0.6237E+02	0.0000E+00
5	0.5000E+02	0.6000E+02	0.6238E+02	0.0000E+00
8	0.2500E+02	0.6000E+02	0.6237E+02	0.0000E+00

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE	AREA	MASS	HEAT
	(IN^2)	(LBM/S)	(BTU/S)
2	0.0000E+00	0.0000E+00	0.0000E+00
3	0.0000E+00	0.0000E+00	0.0000E+00
6	0.0000E+00	0.0000E+00	0.0000E+00
7	0.0000E+00	0.0000E+00	0.0000E+00

BRANCH	UPNODE	DNNODE	OPTION
	12	1	2 1
	23	2	3 1
	34	3	4 1
	56	5	6 1
	67	6	7 1
	78	7	8 1

BRANCH	OPTION	-1:	LENGTH	DIA	EPSD	ANGLE	AREA		
12		0.100E+02		0.250E+00		0.000E+00		0.000E+00	0.491E-01
23		0.100E+02		0.250E+00		0.000E+00		0.000E+00	0.491E-01
34		0.100E+02		0.250E+00		0.000E+00		0.000E+00	0.491E-01
56		0.100E+02		0.500E+00		0.000E+00		0.000E+00	0.196E+00
67		0.100E+02		0.500E+00		0.000E+00		0.000E+00	0.196E+00
78		0.100E+02		0.500E+00		0.000E+00		0.000E+00	0.196E+00

SOLUTION

INTERNAL NODES						
NODE	P (PSI)	TF (F)	Z	RHO	EM (LBM)	QUALITY
				(LBM/FT^3)		
2	0.4185E+02	0.1000E+03	0.2025E-02	0.6200E+02	0.0000E+00	0.0000E+00
3	0.3370E+02	0.7180E+02	0.1709E-02	0.6229E+02	0.0000E+00	0.0000E+00
6	0.4163E+02	0.6002E+02	0.2157E-02	0.6237E+02	0.0000E+00	0.0000E+00
7	0.3327E+02	0.6451E+02	0.1709E-02	0.6235E+02	0.0000E+00	0.0000E+00

BRANCHES

BRANCH	KFACTOR	DELP	FLOW RATE	VELOCITY	REYN. NO.	MACH NO.	ENTROPY GEN.	LOST WORK
	(LBF-S^2/ (LBM-FT)^2)	(PSI)	(LBM/SEC)	(FT/SEC)			BTU/(R-SEC)	LBF-FT/SEC
12	0.150E+04	0.815E+01	0.885E+00	0.419E+02	0.118E+06	0.333E-01	0.384E-04	0.167E+02
23	0.150E+04	0.815E+01	0.885E+00	0.419E+02	0.118E+06	0.333E-01	0.384E-04	0.167E+02
34	0.160E+04	0.870E+01	0.885E+00	0.417E+02	0.844E+05	0.343E-01	0.430E-04	0.178E+02
56	0.412E+02	0.837E+01	0.541E+01	0.636E+02	0.219E+06	0.530E-01	0.258E-03	0.104E+03
67	0.412E+02	0.837E+01	0.541E+01	0.636E+02	0.219E+06	0.530E-01	0.258E-03	0.104E+03
78	0.407E+02	0.827E+01	0.541E+01	0.637E+02	0.234E+06	0.528E-01	0.253E-03	0.103E+03

***** TOTAL ENTROPY GENERATION = 0.890E-03 BTU/(R-SEC) *****

**** TOTAL WORK LOST = 0.661E+00 HP *****

.....
TIME OF ANALYSIS WAS 2.002880000000000E-002 SECS
.....



APPENDIX I—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 6

Radial Flow on a Rotating Disk

Contents	Page
Example 6 Input File	28
Example 6 Output File	32

```

GFSSP VERSION
503
GFSSP INSTALLATION PATH
C:\Program Files\GFSSP\
ANALYST
Paul Schallhorn
INPUT DATA FILE NAME
C:\Program Files\GFSSP\Examples\Ex6\Ex6.dat
OUTPUT FILE NAME
Ex6.out
TITLE
Radial Flow on a Rotating Radial Disk
USETUP
F
DENCON      GRAVITY      ENERGY      MIXTURE      THRUST      STEADY      TRANSV      SAVER
F            F            T            F            F            T            F            F
HEX          HCOEF        REACTING      INERTIA      CONDX        ADDPROP      PRINTI      ROTATION
F            F            F            T            F            F            T            T
BUOYANCY     HRATE          INVAL        MSORCE       MOVBNB       TPA          VARGEO      TVM
F            T            F            F            F            F            F            F
SHEAR        PRNTIN        PRNTADD      OPVALVE      TRANSQ       CONJUG       RADIAT      WINPLOT
F            F            F            F            F            F            F            T
PRESS        INSUC        VARROT       CYCLIC       CHKVALS      WINFILE      DALTON
F            F            F            F            F            T            F
NORMAL       SIMUL        SECONDL      NRSOLVT
F            T            F            F
NNODES       NINT         NBR          NF
13           11          12           1
RELAXK       RELAXD       RELAXH       CC            NITER
1            0.5         1            0.0001        500
NFLUID(I), I = 1, NF
11
NODE         INDEX        DESCRIPTION
1            2          "Node 1"
2            1          "Node 2"
3            1          "Node 3"
4            1          "Node 4"
5            1          "Node 5"
6            1          "Node 6"
7            1          "Node 7"
8            1          "Node 8"
9            1          "Node 9"
10           1          "Node 10"
11           1          "Node 11"
12           1          "Node 12"
13           2          "Node 13"

NODE         PRES  (PSI)    TEMP (DEGF)    MASS SOURC    HEAT SOURC    THRST AREA    CONCENTRATION
1            90          80             0              0              0
2            14.7        70             0              0              0
3            14.7        70             0              0              0
4            14.7        70             0              0              0
5            14.7        70             0              0              0
6            14.7        70             0              0              0
7            14.7        70             0              0              0
8            14.7        70             0              0              0
9            14.7        70             0              0              0
10           14.7        70             0              0              0
11           14.7        70             0              0              0
12           14.7        70             0              0              0
13           30          80             0              0              0

```

INODE	NUMBR	NAMEBR	
2	2	12	23
3	2	23	34
4	2	34	45
5	2	45	56
6	2	56	67
7	2	67	78
8	2	78	89
9	2	89	910
10	2	910	1011
11	2	1011	1112
12	2	1112	1213

BRANCH	UPNODE	DNNODE	OPTION	DESCRIPTION
12	1	2	2	"Restrict 12"
23	2	3	2	"Restrict 23"
34	3	4	2	"Restrict 34"
45	4	5	2	"Restrict 45"
56	5	6	2	"Restrict 56"
67	6	7	2	"Restrict 67"
78	7	8	2	"Restrict 78"
89	8	9	2	"Restrict 89"
910	9	10	2	"Restrict 910"
1011	10	11	2	"Restrict 1011"
1112	11	12	2	"Restrict 1112"
1213	12	13	2	"Restrict 1213"

BRANCH	OPTION	-2	FLOW	COEFF	AREA
12			0		3.1416
23			0		1.8041
34			0		3.2218
45			0		4.6767
56			0		5.7231
67			0		6.2062
78			0		68.33
89			0		6.2062
910			0		5.7231
1011			0		4.6767
1112			0		3.4605
1213			0.02189		6.2299

BRANCH	NOUBR	NMUBR
12	0	
23	1	12
34	1	23
45	1	34
56	1	45
67	1	56
78	1	67
89	1	78
910	1	89
1011	1	910
1112	1	1011
1213	1	1112

BRANCH	NODBR	NMDBR
12	1	23
23	1	34
34	1	45
45	1	56
56	1	67
67	1	78
78	1	89
89	1	910
910	1	1011
1011	1	1112
1112	1	1213
1213	0	

```

BRANCH
12
UPSTRM BR.    ANGLE
DNSTRM BR.    ANGLE
23            0.00000

```

```

BRANCH
23
UPSTRM BR.    ANGLE
12            0.00000
DNSTRM BR.    ANGLE
34            0.00000

```

```

BRANCH
34
UPSTRM BR.    ANGLE
23            0.00000
DNSTRM BR.    ANGLE
45            0.00000

```

```

BRANCH
45
UPSTRM BR.    ANGLE
34            0.00000
DNSTRM BR.    ANGLE
56            0.00000

```

```

BRANCH
56
UPSTRM BR.    ANGLE
45            0.00000
DNSTRM BR.    ANGLE
67            0.00000

```

```

BRANCH
67
UPSTRM BR.    ANGLE
56            0.00000
DNSTRM BR.    ANGLE
78            0.00000

```

```

BRANCH
78
UPSTRM BR.    ANGLE
67            0.00000
DNSTRM BR.    ANGLE
89            0.00000

```

```

BRANCH
89
UPSTRM BR.    ANGLE
78            0.00000
DNSTRM BR.    ANGLE
910           0.00000

```

```

BRANCH
910
UPSTRM BR.    ANGLE
89            0.00000
DNSTRM BR.    ANGLE
1011          0.00000

```

```

BRANCH
1011
  UPSTRM BR.    ANGLE
910             0.00000
  DNSTRM BR.    ANGLE
1112            0.00000
BRANCH
1112
  UPSTRM BR.    ANGLE
1011            0.00000
  DNSTRM BR.    ANGLE
1213            0.00000
BRANCH
1213
  UPSTRM BR.    ANGLE
1112            0.00000
  DNSTRM BR.    ANGLE
NUMBER OF BRANCHES WITH INERTIA
12
12
23
34
45
56
67
78
89
910
1011
1112
1213
NUMBER OF ROTATING BRANCHES
9
BRANCH      UPST RAD      DNST RAD      RPM      K ROT
23          1.25         2.25        5000      0.8671
34          2.25         3.625       5000      0.8158
45          3.625        4.6875      5000      0.763
56          4.6875       5.375       5000      0.7252
67          5.375        5.5         5000      0.7076
89          5.5         5.375       5000      0.7129
910         5.375        4.6875      5000      0.7349
1011        4.6875       3.625       5000      0.7824
1112        3.625        2.65        5000      0.8376

```



```

.....
          G F S S P (Version 5.0)
    Generalized Fluid System Simulation Program
          September, 2006
    Developed by NASA/Marshall Space Flight Center
    Copyright © by Marshall Space Flight Center

```

```

    A generalized computer program to calculate flow
    rates, pressures, temperatures and concentrations
    in a flow network.
.....

```

```

TITLE      :Radial Flow on a Rotating Radial Disk
ANALYST    :Paul Schallhorn
FILEIN     :C:\Program Files\GFSSP\Examples\Ex6\Ex6.dat
FILEOUT    :Ex6.out

```

LOGICAL VARIABLES

```

DENCON      = F
GRAVITY     = F
ENERGY      = T
MIXTURE     = F
THRUST      = F
STEADY      = T
TRANSV      = F
SAVER       = F
HEX         = F
HCOEF       = F
REACTING    = F
INERTIA     = T
CONDX       = F
TWOD        = F
PRINTI      = T
ROTATION    = T
BUOYANCY    = F
HRATE       = T
INVAL       = F
MSORCE      = F
MOVBND      = F
TPA         = F
VARGEO      = F
TVM         = F
SHEAR       = F
PRNTIN      = F
PRNTADD     = F
ADDPROP     = F
PRESS       = F
INSUC       = F
VARROT      = F
NORMAL      = F
SECONDL     = F
CONJUG      = F
NRSOLVT     = F

```

```

NNODES      = 13
NINT        = 11
NBR         = 12
NF          = 1
NVAR        = 23
NHREF       = 2

```

FLUIDS: H2O

BOUNDARY NODES

NODE	P (PSI)	T (F)	RHO (LBM/FT^3)	AREA (IN^2)
1	0.9000E+02	0.8000E+02	0.6224E+02	0.0000E+00
13	0.3000E+02	0.8000E+02	0.6222E+02	0.0000E+00

SOLUTION

INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.9000E+02	0.8000E+02	0.4500E-02	0.6224E+02	0.0000E+00	0.0000E+00
3	0.1237E+03	0.8001E+02	0.6182E-02	0.6225E+02	0.0000E+00	0.0000E+00
4	0.1924E+03	0.8002E+02	0.9618E-02	0.6226E+02	0.0000E+00	0.0000E+00
5	0.2582E+03	0.8004E+02	0.1290E-01	0.6227E+02	0.0000E+00	0.0000E+00
6	0.3048E+03	0.8005E+02	0.1523E-01	0.6228E+02	0.0000E+00	0.0000E+00
7	0.3135E+03	0.8005E+02	0.1566E-01	0.6228E+02	0.0000E+00	0.0000E+00
8	0.3135E+03	0.8005E+02	0.1566E-01	0.6228E+02	0.0000E+00	0.0000E+00
9	0.3046E+03	0.8005E+02	0.1522E-01	0.6228E+02	0.0000E+00	0.0000E+00
10	0.2568E+03	0.8004E+02	0.1283E-01	0.6227E+02	0.0000E+00	0.0000E+00
11	0.1877E+03	0.8002E+02	0.9379E-02	0.6226E+02	0.0000E+00	0.0000E+00
12	0.1328E+03	0.8001E+02	0.6637E-02	0.6225E+02	0.0000E+00	0.0000E+00

BRANCHES

BRANCH	KFACTOR (LBF-S^2/ (LBM-FT) ^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.000E+00	0.850E-11	0.729E+01	0.537E+01	0.965E+05	0.437E-02	0.000E+00	0.000E+00
23	0.000E+00	-0.337E+02	0.729E+01	0.935E+01	0.127E+06	0.762E-02	0.000E+00	0.000E+00
34	0.000E+00	-0.688E+02	0.729E+01	0.524E+01	0.953E+05	0.426E-02	0.000E+00	0.000E+00
45	0.000E+00	-0.658E+02	0.729E+01	0.361E+01	0.792E+05	0.294E-02	0.000E+00	0.000E+00
56	0.000E+00	-0.466E+02	0.729E+01	0.295E+01	0.716E+05	0.240E-02	0.000E+00	0.000E+00
67	0.000E+00	-0.871E+01	0.729E+01	0.272E+01	0.688E+05	0.221E-02	0.000E+00	0.000E+00
78	0.000E+00	0.854E-11	0.729E+01	0.247E+00	0.207E+05	0.201E-03	0.000E+00	0.000E+00
89	0.000E+00	0.884E+01	0.729E+01	0.272E+01	0.688E+05	0.221E-02	0.000E+00	0.000E+00
910	0.000E+00	0.478E+02	0.729E+01	0.295E+01	0.716E+05	0.240E-02	0.000E+00	0.000E+00
1011	0.000E+00	0.692E+02	0.729E+01	0.361E+01	0.792E+05	0.294E-02	0.000E+00	0.000E+00
1112	0.000E+00	0.549E+02	0.729E+01	0.487E+01	0.920E+05	0.397E-02	0.000E+00	0.000E+00
1213	0.278E+03	0.103E+03	0.729E+01	0.271E+01	0.686E+05	0.221E-02	0.413E-02	0.173E+04

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 6 ITERATIONS

TAU = 100000000.000000 ISTEP = 1

.....

TIME OF ANALYSIS WAS 3.004320000000000E-002 SECS

.....



APPENDIX J—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 7

Flow in a Long Bearing Squeeze Film Damper

<u>Contents</u>	<u>Page</u>
Example 7 Input File	35
Example 7 Output File	38

```

GFSSP VERSION
503
GFSSP INSTALLATION PATH
C:\Program Files\GFSSP\
ANALYST
Paul Schallhorn
INPUT DATA FILE NAME
C:\Program Files\GFSSP\Examples\Ex7\Ex7.dat
OUTPUT FILE NAME
Ex7.out
TITLE
Flow in a Long Bearing Squeeze Film Damper
USETUP
F
DENCON      GRAVITY      ENERGY      MIXTURE      THRUST      STEADY      TRANSV      SAVER
T            F            F            F            F            T            F            F
HEX          HCOEF        REACTING      INERTIA      CONDX        ADDPROP      PRINTI      ROTATION
F            F            F            F            F            F            F            F
BUOYANCY     HRATE          INVAL        MSORCE       MOVBNB       TPA          VARGEO      TVM
F            T            F            F            T            F            F            F
SHEAR        PRNTIN        PRNTADD      OPVALVE      TRANSQ       CONJUG       RADIAT      WINPLOT
F            F            T            F            F            F            F            F
PRESS        INSUC        VARROT       CYCLIC       CHKVALS      WINFILE      DALTON
F            F            F            F            F            T            F
NORMAL       SIMUL          SECONDL      NRSOLVT
F            T            T            F
NNODES       NINT          NBR          NF
20           18          19          0
RELAXK        RELAXD        RELAXH       CC            NITER
1            0.5          1            0.0001        500
RHOREF        EMUREF
57.806       0.005932
NODE          INDEX      DESCRIPTION
1            2          "Node 1"
2            1          "Node 2"
3            1          "Node 3"
4            1          "Node 4"
5            1          "Node 5"
6            1          "Node 6"
7            1          "Node 7"
8            1          "Node 8"
9            1          "Node 9"
10           1          "Node 10"
11           1          "Node 11"
12           1          "Node 12"
13           1          "Node 13"
14           1          "Node 14"
15           1          "Node 15"
16           1          "Node 16"
17           1          "Node 17"
18           1          "Node 18"
19           1          "Node 19"
20           2          "Node 20"
NODE          PRES (PSI)  MASS SOURC  HEAT SOURC  THRST AREA
1            0            0            0            0
2            0            0            0            0
3            0            0            0            0
4            0            0            0            0
5            0            0            0            0
6            0            0            0            0
7            0            0            0            0
8            0            0            0            0
9            0            0            0            0
10           10           0            0            0
11           0            0            0            0
12           0            0            0            0
13           0            0            0            0
14           0            0            0            0
15           0            0            0            0
16           0            0            0            0
17           0            0            0            0

```

18	0	0	0	0
19	0	0	0	0
20	0	0	0	0

INODE	NUMBR	NAMEBR	
2	2	12	23
3	2	23	34
4	2	34	45
5	2	45	56
6	2	56	67
7	2	67	78
8	2	78	89
9	2	89	910
10	2	910	1011
11	2	1011	1112
12	2	1112	1213
13	2	1213	1314
14	2	1314	1415
15	2	1415	1516
16	2	1516	1617
17	2	1617	1718
18	2	1718	1819
19	2	1819	1920

BRANCH	UPNODE	DNNODE	OPTION	DESCRIPTION
12	1	2	3	"Duct 12"
23	2	3	3	"Duct 23"
34	3	4	3	"Duct 34"
45	4	5	3	"Duct 45"
56	5	6	3	"Duct 56"
67	6	7	3	"Duct 67"
78	7	8	3	"Duct 78"
89	8	9	3	"Duct 89"
910	9	10	3	"Duct 910"
1011	10	11	3	"Duct 1011"
1112	11	12	3	"Duct 1112"
1213	12	13	3	"Duct 1213"
1314	13	14	3	"Duct 1314"
1415	14	15	3	"Duct 1415"
1516	15	16	3	"Duct 1516"
1617	16	17	3	"Duct 1617"
1718	17	18	3	"Duct 1718"
1819	18	19	3	"Duct 1819"
1920	19	20	3	"Duct 1920"

BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
12			0.82673	0.01258	0.94	1	0.0118252
BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
23			0.8267	0.01799	0.94	1	0.0169106
BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
34			0.82673	0.02822	0.94	1	0.0265268
BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
45			0.82673	0.04217	0.94	1	0.0396398
BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
56			0.82673	0.05832	0.94	1	0.0548208
BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
67			0.82673	0.07492	0.94	1	0.0704248
BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
78			0.82673	0.09018	0.94	1	0.0847692
BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
89			0.82673	0.10244	0.94	1	0.0962936
BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
910			0.82673	0.11037	0.94	1	0.103748
BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
1011			0.82673	0.11311	0.94	1	0.106323
BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
1112			0.82673	0.11037	0.94	1	0.103748
BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
1213			0.82673	0.10244	0.94	1	0.0962936

BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
1314			0.82673	0.09018	0.94	1	0.0847692
BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
1415			0.82673	0.07492	0.94	1	0.0704248
BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
1516			0.82673	0.05832	0.94	1	0.0548208
BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
1617			0.82673	0.04217	0.94	1	0.0396398
BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
1718			0.82673	0.02822	0.94	1	0.0265268
BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
1819			0.82673	0.01799	0.94	1	0.0169106
BRANCH	OPTION	-3	LENGTH	HEIGHT	WIDTH	TYPE	AREA
1920			0.82673	0.01258	0.94	1	0.0118252

NUMBER OF NODES WITH MOVING BOUNDARY

18

NODE	AREAN	VBOUND
2	0.77713	0.25618
3	0.77713	0.4846
4	0.77713	0.6605
5	0.77713	0.76483
6	0.77713	0.78628
7	0.77713	0.72252
8	0.77713	0.58047
9	0.77713	0.37551
10	0.77713	0.12986
11	0.77713	-0.12986
12	0.77713	-0.37551
13	0.77713	-0.58047
14	0.77713	-0.72252
15	0.77713	-0.78628
16	0.77713	-0.76483
18	0.77713	-0.4846
19	0.77713	-0.25618

```

.....
          G F S S P (Version 5.0)
    Generalized Fluid System Simulation Program
          September, 2006
    Developed by NASA/Marshall Space Flight Center
    Copyright © by Marshall Space Flight Center

```

```

A generalized computer program to calculate flow
rates, pressures, temperatures and concentrations
in a flow network.
.....

```

```

TITLE      :Flow in a Long Bearing Squeeze Film Damper
ANALYST    :Paul Schallhorn
FILEIN     :C:\Program Files\GFSSP\Examples\Ex7\Ex7.dat
FILEOUT    :Ex7.out
  LOGICAL VARIABLES
DENCON     = T
GRAVITY    = F
ENERGY     = F
MIXTURE    = F
THRUST     = F
STEADY     = T
TRANSV     = F
SAVER      = F
HEX        = F
HCOEF      = F
REACTING   = F
INERTIA    = F
CONDX      = F
TWOD       = F
PRINTI     = F
ROTATION   = F
BUOYANCY   = F
HRATE      = T
INVAL      = F
MSORCE     = F
MOVBND     = T
TPA        = F
VARGEO     = F
TVM        = F
SHEAR      = F
PRNTIN     = F
PRNTADD    = T
ADDPROP    = F
PRESS      = F
INSUC      = F
VARROT     = F
NORMAL     = F
SECONDL    = T
CONJUG     = F
NRSOLVT    = F

NNODES     = 20
NINT       = 18
NBR        = 19
NF         = 0
NVAR       = 37
NHREF      = 2
RHOREF     = 57.8060 LBM/FT**3
EMUREF     = 0.5932E-02 LBM/FT-SEC
BOUNDARY   NODES
NODE       P          AREA
(PSI)      (IN^2)
  1        0.0000E+00    0.0000E+00
 20        0.0000E+00    0.0000E+00

```

SOLUTION

INTERNAL NODES

NODE	P (PSI)	EM (LBM)
2	0.1365E+02	0.0000E+00
3	0.1273E+02	0.0000E+00
4	0.9716E+01	0.0000E+00
5	0.7660E+01	0.0000E+00
6	0.5812E+01	0.0000E+00
7	0.4250E+01	0.0000E+00
8	0.2901E+01	0.0000E+00
9	0.1690E+01	0.0000E+00
10	0.5551E+00	0.0000E+00
11	-0.5551E+00	0.0000E+00
12	-0.1690E+01	0.0000E+00
13	-0.2901E+01	0.0000E+00
14	-0.4250E+01	0.0000E+00
15	-0.5812E+01	0.0000E+00
16	-0.7660E+01	0.0000E+00
17	-0.9716E+01	0.0000E+00
18	-0.1273E+02	0.0000E+00
19	-0.1365E+02	0.0000E+00

BRANCHES

BRANCH	KFACTOR (LBF-S ² / (LBM-FT) ²)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.440E+06	-0.136E+02	-0.668E-01	-0.141E+02	0.140E+04	0.000E+00	0.635E-05	0.227E+01
23	0.770E+06	0.920E+00	0.131E-01	0.193E+01	0.230E+03	0.000E+00	0.841E-07	0.301E-01
34	0.161E+05	0.301E+01	0.164E+00	0.154E+02	0.230E+04	0.000E+00	0.345E-05	0.123E+01
45	0.216E+04	0.206E+01	0.370E+00	0.233E+02	0.425E+04	0.000E+00	0.530E-05	0.190E+01
56	0.718E+03	0.185E+01	0.609E+00	0.277E+02	0.594E+04	0.000E+00	0.784E-05	0.280E+01
67	0.308E+03	0.156E+01	0.854E+00	0.302E+02	0.735E+04	0.000E+00	0.929E-05	0.332E+01
78	0.167E+03	0.135E+01	0.108E+01	0.317E+02	0.846E+04	0.000E+00	0.101E-04	0.363E+01
89	0.110E+03	0.121E+01	0.126E+01	0.326E+02	0.927E+04	0.000E+00	0.106E-04	0.380E+01
910	0.861E+02	0.113E+01	0.138E+01	0.331E+02	0.976E+04	0.000E+00	0.109E-04	0.389E+01
1011	0.795E+02	0.111E+01	0.142E+01	0.332E+02	0.993E+04	0.000E+00	0.110E-04	0.392E+01
1112	0.861E+02	0.113E+01	0.138E+01	0.331E+02	0.976E+04	0.000E+00	0.109E-04	0.389E+01
1213	0.110E+03	0.121E+01	0.126E+01	0.326E+02	0.927E+04	0.000E+00	0.106E-04	0.380E+01
1314	0.167E+03	0.135E+01	0.108E+01	0.317E+02	0.846E+04	0.000E+00	0.101E-04	0.363E+01
1415	0.308E+03	0.156E+01	0.854E+00	0.302E+02	0.735E+04	0.000E+00	0.929E-05	0.332E+01
1516	0.718E+03	0.185E+01	0.609E+00	0.277E+02	0.594E+04	0.000E+00	0.784E-05	0.280E+01
1617	0.216E+04	0.206E+01	0.370E+00	0.233E+02	0.425E+04	0.000E+00	0.530E-05	0.190E+01
1718	0.161E+05	0.301E+01	0.164E+00	0.154E+02	0.230E+04	0.000E+00	0.345E-05	0.123E+01
1819	0.770E+06	0.920E+00	0.131E-01	0.193E+01	0.230E+03	0.000E+00	0.841E-07	0.301E-01
1920	0.440E+06	-0.136E+02	-0.668E-01	-0.141E+02	0.140E+04	0.000E+00	0.635E-05	0.227E+01

***** TOTAL ENTROPY GENERATION = 0.139E-03 BTU/(R-SEC) *****

**** TOTAL WORK LOST = 0.903E-01 HP *****

.....

TIME OF ANALYSIS WAS 1.001440000000000E-002 SECS

.....



APPENDIX K—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 8

Simulation of the Blow Down of a Pressurized Tank

Contents	Page
Example 8 Input File	41
Example 8 History File	42
Example 8 Output File (Partial)	43

```

GFSSP VERSION
503
GFSSP INSTALLATION PATH
C:\Program Files\GFSSP\
ANALYST
Alok Majumdar
INPUT DATA FILE NAME
C:\Program Files\GFSSP\Examples\Ex8\Ex8.dat
OUTPUT FILE NAME
Ex8.out
TITLE
Simulation of the Blow Down of a Pressurized Tank
USETUP
F
DENCON      GRAVITY      ENERGY      MIXTURE      THRUST      STEADY      TRANSV      SAVER
F            F            T            F            F            F            T            F
HEX          HCOEF        REACTING      INERTIA      CONDX        ADDPROP      PRINTI      ROTATION
F            F            F            F            F            T            T            F
BUOYANCY     HRATE          INVAL         MSORCE       MOVBNB       TPA          VARGEO      TVM
F            F            F            F            F            F            F            F
SHEAR        PRNTIN        PRNTADD       OPVALVE      TRANSQ       CONJUG       RADIAT      WINPLOT
F            T            T            F            F            F            F            T
PRESS        INSUC        VARROT        CYCLIC       CHKVALS      WINFILE      DALTON
F            F            F            F            F            T            F
NORMAL       SIMUL          SECONDL       NRSOLVT
F            T            T            F
NNODES       NINT          NBR           NF
2            1            1            1
RELAXK       RELAXD        RELAXH        CC            NITER
1            0.5        1            0.0001        500
DTAU         TIMEF         TIMEL         NPSTEP        NPWSTEP
1            0            200          25            1
NFLUID(I), I = 1, NF
33
RREF         CPREF        GAMREF        EMUREF        AKREF         PREF          TREF          HREF          SREF
53.34        0.24          1.3999        1.26e-05      4.133e-06     14.7          -459          0            0
NODE         INDEX        DESCRIPTION
1            1            "Node 1"
2            2            "Node 2"
NODE         PRES (PSI)    TEMP (DEGF)   MASS          SOURC          HEAT SOURC    THRST AREA NODE-VOLUME CONCENTRATION
1            100          80            0            0            0            17280
ex8hs2.dat
INODE        NUMBR        NAMEBR
1            1            12
BRANCH       UPNODE       DNNODE        OPTION        DESCRIPTION
12           1            2            22           "Orifice 12"
BRANCH       OPTION -22    AREA          FLOW COEF
12           0.00785    1
INITIAL FLOWRATES IN BRANCHES FOR UNSTEADY FLOW
12 0

```

EXAMPLE 8 HISTORY FILE

EX8HS2.DAT

2

0	14.700	80.00	1.00
---	--------	-------	------

1000	14.700	80.00	1.00
------	--------	-------	------

```
.....
G F S S P (Version 5.0)
Generalized Fluid System Simulation Program
September, 2006
Developed by NASA/Marshall Space Flight Center
Copyright © by Marshall Space Flight Center
```

```
A generalized computer program to calculate flow
rates, pressures, temperatures and concentrations
in a flow network.
.....
```

```
TITLE      :Simulation of the Blow Down of a Pressurized Tank
ANALYST    :Alok Majumdar
FILEIN     :C:\Program Files\GFSSP\Examples\Ex8\Ex8.dat
FILEOUT    :Ex8.out
```

LOGICAL VARIABLES

```
DENCON    = F
GRAVITY   = F
ENERGY    = T
MIXTURE   = F
THRUST    = F
STEADY    = F
TRANSV    = T
SAVER     = F
HEX       = F
HCOEF     = F
REACTING  = F
INERTIA   = F
CONDX     = F
TWOD      = F
PRINTI    = T
ROTATION  = F
BUOYANCY  = F
HRATE     = F
INVAL     = F
MSORCE    = F
MOVBND    = F
TPA       = F
VARGEO    = F
TVM       = F
SHEAR     = F
PRNTIN    = T
PRNTADD   = T
ADDPROP   = T
PRESS     = F
INSUC     = F
VARROT    = F
NORMAL    = F
SECONDNL  = T
CONJUG    = F
NRSOLVT   = F
```

```
NNODES    = 2
NINT      = 1
NBR       = 1
NF        = 1
NVAR      = 3
NHREF     = 2
```

```
FLUIDS: IDEL
```

```

BOUNDARY NODES
  NODE      P      T      RHO      AREA
            (PSI)    (F)    (LBM/FT^3)  (IN^2)
  2      0.1470E+02  0.8000E+02  0.7355E-01  0.0000E+00
INPUT SPECIFICATIONS FOR INTERNAL NODES
  NODE      AREA      MASS      HEAT
            (IN^2)    (LBM/S)  (BTU/LBM)
  1      0.0000E+00  0.0000E+00  0.0000E+00
BRANCH  UPNODE  DNNODE  OPTION
  12      1      2      22
BRANCH  OPTION  -22  FLOW COEF  AREA
  12      0.100E+01  0.785E-02
INITIAL GUESS FOR INTERNAL NODES
  NODE      P (PSI)      TF (F)      Z (COMP)      RHO      QUALITY
            (LBM/FT^3)
  1      0.1000E+03  0.8000E+02  0.1000E+01  0.5003E+00  0.0000E+00
TRIAL SOLUTION
BRANCH  DELP (PSI)  FLOWRATE (LBM/SEC)
  12      0.0000  0.0000

SOLUTION SATISFIED CONVERGENCE CRITERION OF  0.100E-03 IN  7 ITERATIONS
TAU =  1.000000000000000      ISTEP = 1
      :
      :
      :
      :
SOLUTION SATISFIED CONVERGENCE CRITERION OF  0.100E-03 IN  7 ITERATIONS
TAU =  24.000000000000000      ISTEP = 24
      ISTEP = 25      TAU = 0.25000E+02
BOUNDARY NODES
  NODE      P (PSI)      TF (F)      Z (COMP)      RHO      QUALITY
            (LBM/FT^3)
  2      0.1470E+02  0.8000E+02  0.1000E+01  0.7355E-01  0.0000E+00
SOLUTION
INTERNAL NODES
  NODE      P (PSI)      TF (F)      Z      RHO      EM (LBM)      QUALITY
            (LBM/FT^3)
  1      0.8831E+02  0.6118E+02  0.1000E+01  0.4578E+00  0.4578E+01  0.0000E+00
  NODE      H      ENTROPY      EMU      COND      CP      GAMA
            BTU/LB      BTU/LB-R      LBM/FT-SEC      BTU/FT-S-R      BTU/LB-R
  1      0.1294E+03  0.1501E+01  0.1260E-04  0.4133E-05  0.2400E+00  0.1400E+01
BRANCHES
BRANCH  KFACTOR      DELP      FLOW RATE      VELOCITY      REYN. NO.      MACH NO.      ENTROPY GEN.      LOST WORK
            (LBF-S^2/      (PSI)      (LBM/SEC)      (FT/SEC)
            (LBM-FT)^2)
  12      0.000E+00  0.736E+02  0.162E-01  0.647E+03  0.196E+06  0.579E+00  0.000E+00  0.000E+00

***** TOTAL ENTROPY GENERATION =  0.000E+00 BTU/(R-SEC) *****
**** TOTAL WORK LOST =  0.000E+00 HP ****

SOLUTION SATISFIED CONVERGENCE CRITERION OF  0.100E-03 IN  7 ITERATIONS
TAU =  25.000000000000000      ISTEP = 25
      :
      :
      :
      :

```

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 7 ITERATIONS
TAU = 99.0000000000000 ISTEP = 99

ISTEP = 100 TAU = 0.10000E+03

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
2	0.1470E+02	0.8000E+02	0.1000E+01	0.7355E-01	0.0000E+00

SOLUTION

INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
1	0.6159E+02	0.1025E+02	0.1000E+01	0.3539E+00	0.3539E+01	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
1	0.1294E+03	0.1501E+01	0.1260E-04	0.4133E-05	0.2400E+00	0.1400E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/ (LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/ (R-SEC)	LOST WORK LBF-FT/SEC
12	0.000E+00	0.469E+02	0.119E-01	0.615E+03	0.144E+06	0.579E+00	0.000E+00	0.000E+00

***** TOTAL ENTROPY GENERATION = 0.000E+00 BTU/ (R-SEC) *****

**** TOTAL WORK LOST = 0.000E+00 HP ****

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 7 ITERATIONS
TAU = 100.0000000000000 ISTEP = 100

:
:
:
:
:

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 7 ITERATIONS
TAU = 199.0000000000000 ISTEP = 199

ISTEP = 200 TAU = 0.20000E+03

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
2	0.1470E+02	0.8000E+02	0.1000E+01	0.7355E-01	0.0000E+00

SOLUTION

INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
1	0.3914E+02	-0.4681E+02	0.1000E+01	0.2560E+00	0.2560E+01	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
1	0.1294E+03	0.1501E+01	0.1260E-04	0.4133E-05	0.2400E+00	0.1400E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/ (LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/ (R-SEC)	LOST WORK LBF-FT/SEC
12	0.000E+00	0.244E+02	0.804E-02	0.576E+03	0.976E+05	0.579E+00	0.000E+00	0.000E+00

***** TOTAL ENTROPY GENERATION = 0.000E+00 BTU/ (R-SEC) *****

**** TOTAL WORK LOST = 0.000E+00 HP ****

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 7 ITERATIONS
TAU = 200.0000000000000 ISTEP = 200

.....
TIME OF ANALYSIS WAS 0.260374400000000 SECS
.....



APPENDIX L—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 9

A Reciprocating Piston-Cylinder

Contents	Page
Example 9 Input File	47
Example 9 History File	48
Example 9 Output File (Partial)	51

```

GFSSP VERSION
503
GFSSP INSTALLATION PATH
C:\Program Files\GFSSP\
ANALYST
Paul Schallhorn
INPUT DATA FILE NAME
C:\Program Files\GFSSP\Examples\Ex9\Ex9.dat
OUTPUT FILE NAME
Ex9.out
TITLE
A Reciprocating Piston-Cylinder
USETUP
F
DENCON      GRAVITY      ENERGY      MIXTURE      THRUST      STEADY      TRANSV      SAVER
F            F            T            F            F            F            T            F
HEX          HCOEF        REACTING      INERTIA      CONDX        ADDPROP      PRINTI      ROTATION
F            F            F            F            F            F            F            F
BUOYANCY     HRATE          INVAL        MSORCE       MOVBNB       TPA          VARGEO      TVM
F            T            F            F            T            F            T            F
SHEAR        PRNTIN        PRNTADD      OPVALVE      TRANSQ       CONJUG       RADIAT      WINPLOT
F            F            T            F            F            F            F            T
PRESS        INSUC        VARROT       CYCLIC       CHKVALS      WINFILE      DALTON
F            F            F            F            F            F            F
NORMAL       SIMUL          SECONDL      NRSOLVT
F            T            T            F
NNODES       NINT          NBR          NF
2            2            1            1
RELAXK        RELAXD        RELAXH       CC            NITER
1            0.5        1            0.0001        500
DTAU          TIMEF        TIMEL        NPSTEP       NPWSTEP
0.0001       0            0.05        1            1
NFLUID(I), I = 1, NF
4
NODE          INDEX      DESCRIPTION
1            1          "Node 1"
2            1          "Node 2"
NODE          PRES (PSI)    TEMP (DEGF)    MASS SOURC     HEAT SOURC     THRST AREA     NODE-VOLUME     CONCENTRATION
1            14.7        75            0              0              0              0              0
2            14.7        75            0              0              0              0
ex9vg.dat
INODE         NUMBR        NAMEBR
1            1          12
2            1          12

BRANCH         UPNODE        DNNODE        OPTION        DESCRIPTION
12            1          2            1            "Pipe 12"
BRANCH         OPTION -1      LENGTH        DIA           EPSD           ANGLE          AREA
12            7          3            0            0            7.0686
INITIAL FLOWRATES IN BRANCHES FOR UNSTEADY FLOW
12            0
NUMBER OF NODES WITH MOVING BOUNDARY
2
NODE
1
2

```


VARIABLE GEOMETRY HISTORY FILE

```

41
0.000000      0.0000      0.0000      0.0000      0.0000
0.001250      0.0000      0.0000      0.0000      0.0000
0.002500      0.0000      0.0000      0.0000      0.0000
0.003750      0.0000      0.0000      0.0000      0.0000
0.005000      0.0000      0.0000      0.0000      0.0000
0.006250      0.0000      0.0000      0.0000      0.0000
0.007500      0.0000      0.0000      0.0000      0.0000
0.008750      0.0000      0.0000      0.0000      0.0000
0.010000      0.0000      0.0000      0.0000      0.0000
0.011250      0.0000      0.0000      0.0000      0.0000
0.012500      0.0000      0.0000      0.0000      0.0000
0.013750      0.0000      0.0000      0.0000      0.0000
0.015000      0.0000      0.0000      0.0000      0.0000
0.016250      0.0000      0.0000      0.0000      0.0000
0.017500      0.0000      0.0000      0.0000      0.0000
0.018750      0.0000      0.0000      0.0000      0.0000
0.020000      0.0000      0.0000      0.0000      0.0000
0.021250      0.0000      0.0000      0.0000      0.0000
0.022500      0.0000      0.0000      0.0000      0.0000
0.023750      0.0000      0.0000      0.0000      0.0000
0.025000      0.0000      0.0000      0.0000      0.0000
0.026250      0.0000      0.0000      0.0000      0.0000
0.027500      0.0000      0.0000      0.0000      0.0000
0.028750      0.0000      0.0000      0.0000      0.0000
0.030000      0.0000      0.0000      0.0000      0.0000
0.031250      0.0000      0.0000      0.0000      0.0000
0.032500      0.0000      0.0000      0.0000      0.0000
0.033750      0.0000      0.0000      0.0000      0.0000
0.035000      0.0000      0.0000      0.0000      0.0000
0.036250      0.0000      0.0000      0.0000      0.0000
0.037500      0.0000      0.0000      0.0000      0.0000
0.038750      0.0000      0.0000      0.0000      0.0000
0.040000      0.0000      0.0000      0.0000      0.0000
0.041250      0.0000      0.0000      0.0000      0.0000
0.042500      0.0000      0.0000      0.0000      0.0000
0.043750      0.0000      0.0000      0.0000      0.0000
0.045000      0.0000      0.0000      0.0000      0.0000
0.046250      0.0000      0.0000      0.0000      0.0000
0.047500      0.0000      0.0000      0.0000      0.0000
0.048750      0.0000      0.0000      0.0000      0.0000
0.050000      0.0000      0.0000      0.0000      0.0000
BRANCH VOLUME
0.000000      49.48004      0.0000      100.000      0.0000
0.001250      49.21895      0.0000      100.000      0.0000
0.002500      48.44213      0.0000      100.000      0.0000
0.003750      47.16871      0.0000      100.000      0.0000
0.005000      45.43005      0.0000      100.000      0.0000
0.006250      43.26896      0.0000      100.000      0.0000
0.007500      40.73865      0.0000      100.000      0.0000
0.008750      37.90143      0.0000      100.000      0.0000
0.010000      34.82716      0.0000      100.000      0.0000
0.011250      31.59153      0.0000      100.000      0.0000
0.012500      28.27423      0.0000      100.000      0.0000
0.013750      24.95692      0.0000      100.000      0.0000
0.015000      21.72130      0.0000      100.000      0.0000
0.016250      18.64704      0.0000      100.000      0.0000
0.017500      15.80983      0.0000      100.000      0.0000
0.018750      13.27954      0.0000      100.000      0.0000
0.020000      11.11847      0.0000      100.000      0.0000
0.021250      9.379835      0.0000      100.000      0.0000
0.022500      8.106441      0.0000      100.000      0.0000
0.023750      7.329646      0.0000      100.000      0.0000
0.025000      7.068578      0.0000      100.000      0.0000
0.026250      7.329646      0.0000      100.000      0.0000
0.027500      8.106441      0.0000      100.000      0.0000
0.028750      9.379835      0.0000      100.000      0.0000
0.030000      11.11847      0.0000      100.000      0.0000
0.031250      13.27954      0.0000      100.000      0.0000
0.032500      15.80983      0.0000      100.000      0.0000

```

0.033750	18.64704	0.0000	100.000	0.0000
0.035000	21.72130	0.0000	100.000	0.0000
0.036250	24.95692	0.0000	100.000	0.0000
0.037500	28.27423	0.0000	100.000	0.0000
0.038750	31.59153	0.0000	100.000	0.0000
0.040000	34.82716	0.0000	100.000	0.0000
0.041250	37.90143	0.0000	100.000	0.0000
0.042500	40.73865	0.0000	100.000	0.0000
0.043750	43.26896	0.0000	100.000	0.0000
0.045000	45.43005	0.0000	100.000	0.0000
0.046250	47.16871	0.0000	100.000	0.0000
0.047500	48.44213	0.0000	100.000	0.0000
0.048750	49.21895	0.0000	100.000	0.0000
0.050000	49.48004	0.0000	100.000	0.0000
BRANCH	AREA			
0.000000	7.06858347	1.0000	1.0000	1.0000
0.001250	7.06858347	1.0000	1.0000	1.0000
0.002500	7.06858347	1.0000	1.0000	1.0000
0.003750	7.06858347	1.0000	1.0000	1.0000
0.005000	7.06858347	1.0000	1.0000	1.0000
0.006250	7.06858347	1.0000	1.0000	1.0000
0.007500	7.06858347	1.0000	1.0000	1.0000
0.008750	7.06858347	1.0000	1.0000	1.0000
0.010000	7.06858347	1.0000	1.0000	1.0000
0.011250	7.06858347	1.0000	1.0000	1.0000
0.012500	7.06858347	1.0000	1.0000	1.0000
0.013750	7.06858347	1.0000	1.0000	1.0000
0.015000	7.06858347	1.0000	1.0000	1.0000
0.016250	7.06858347	1.0000	1.0000	1.0000
0.017500	7.06858347	1.0000	1.0000	1.0000
0.018750	7.06858347	1.0000	1.0000	1.0000
0.020000	7.06858347	1.0000	1.0000	1.0000
0.021250	7.06858347	1.0000	1.0000	1.0000
0.022500	7.06858347	1.0000	1.0000	1.0000
0.023750	7.06858347	1.0000	1.0000	1.0000
0.025000	7.06858347	1.0000	1.0000	1.0000
0.026250	7.06858347	1.0000	1.0000	1.0000
0.027500	7.06858347	1.0000	1.0000	1.0000
0.028750	7.06858347	1.0000	1.0000	1.0000
0.030000	7.06858347	1.0000	1.0000	1.0000
0.031250	7.06858347	1.0000	1.0000	1.0000
0.032500	7.06858347	1.0000	1.0000	1.0000
0.033750	7.06858347	1.0000	1.0000	1.0000
0.035000	7.06858347	1.0000	1.0000	1.0000
0.036250	7.06858347	1.0000	1.0000	1.0000
0.037500	7.06858347	1.0000	1.0000	1.0000
0.038750	7.06858347	1.0000	1.0000	1.0000
0.040000	7.06858347	1.0000	1.0000	1.0000
0.041250	7.06858347	1.0000	1.0000	1.0000
0.042500	7.06858347	1.0000	1.0000	1.0000
0.043750	7.06858347	1.0000	1.0000	1.0000
0.045000	7.06858347	1.0000	1.0000	1.0000
0.046250	7.06858347	1.0000	1.0000	1.0000
0.047500	7.06858347	1.0000	1.0000	1.0000
0.048750	7.06858347	1.0000	1.0000	1.0000
0.050000	7.06858347	1.0000	1.0000	1.0000
1				
0.000000	7.06858347	0.000000		
0.001250	7.06858347	2.457263		
0.002500	7.06858347	4.854020		
0.003750	7.06858347	7.131254		
0.005000	7.06858347	9.232895		
0.006250	7.06858347	11.10719		
0.007500	7.06858347	12.70799		
0.008750	7.06858347	13.99588		
0.010000	7.06858347	14.93914		
0.011250	7.06858347	15.51456		
0.012500	7.06858347	15.70795		
0.013750	7.06858347	15.51456		
0.015000	7.06858347	14.93916		
0.016250	7.06858347	13.99590		

0.017500	7.06858347	12.70802
0.018750	7.06858347	11.10722
0.020000	7.06858347	9.232928
0.021250	7.06858347	7.131292
0.022500	7.06858347	4.854059
0.023750	7.06858347	2.457304
0.025000	7.06858347	0.000000
0.026250	7.06858347	-2.457222
0.027500	7.06858347	-4.853980
0.028750	7.06858347	-7.131217
0.030000	7.06858347	-9.232861
0.031250	7.06858347	-11.10716
0.032500	7.06858347	-12.70797
0.033750	7.06858347	-13.99586
0.035000	7.06858347	-14.93913
0.036250	7.06858347	-15.51455
0.037500	7.06858347	-15.70795
0.038750	7.06858347	-15.51457
0.040000	7.06858347	-14.93917
0.041250	7.06858347	-13.99592
0.042500	7.06858347	-12.70804
0.043750	7.06858347	-11.10725
0.045000	7.06858347	-9.232962
0.046250	7.06858347	-7.131329
0.047500	7.06858347	-4.854099
0.048750	7.06858347	-2.457345
0.050000	7.06858347	0.000000
2		
0.000000	7.06858347	0.000000
0.001250	7.06858347	2.457263
0.002500	7.06858347	4.854020
0.003750	7.06858347	7.131254
0.005000	7.06858347	9.232895
0.006250	7.06858347	11.10719
0.007500	7.06858347	12.70799
0.008750	7.06858347	13.99588
0.010000	7.06858347	14.93914
0.011250	7.06858347	15.51456
0.012500	7.06858347	15.70795
0.013750	7.06858347	15.51456
0.015000	7.06858347	14.93916
0.016250	7.06858347	13.99590
0.017500	7.06858347	12.70802
0.018750	7.06858347	11.10722
0.020000	7.06858347	9.232928
0.021250	7.06858347	7.131292
0.022500	7.06858347	4.854059
0.023750	7.06858347	2.457304
0.025000	7.06858347	0.000000
0.026250	7.06858347	-2.457222
0.027500	7.06858347	-4.853980
0.028750	7.06858347	-7.131217
0.030000	7.06858347	-9.232861
0.031250	7.06858347	-11.10716
0.032500	7.06858347	-12.70797
0.033750	7.06858347	-13.99586
0.035000	7.06858347	-14.93913
0.036250	7.06858347	-15.51455
0.037500	7.06858347	-15.70795
0.038750	7.06858347	-15.51457
0.040000	7.06858347	-14.93917
0.041250	7.06858347	-13.99592
0.042500	7.06858347	-12.70804
0.043750	7.06858347	-11.10725
0.045000	7.06858347	-9.232962
0.046250	7.06858347	-7.131329
0.047500	7.06858347	-4.854099
0.048750	7.06858347	-2.457345
0.050000	7.06858347	0.000000

```

.....
      G F S S P (Version 5.0)
    Generalized Fluid System Simulation Program
      September, 2006
    Developed by NASA/Marshall Space Flight Center
    Copyright © by Marshall Space Flight Center

```

```

A generalized computer program to calculate flow
rates, pressures, temperatures and concentrations
in a flow network.
.....

```

```

TITLE   :A Reciprocating Piston-Cylinder
ANALYST :Paul Schallhorn
FILEIN  :C:\Program Files\GFSSP\Examples\Ex9\Ex9.dat
FILEOUT :Ex9.out

```

LOGICAL VARIABLES

```

DENCON   = F
GRAVITY  = F
ENERGY   = T
MIXTURE  = F
THRUST   = F
STEADY   = F
TRANSV   = T
SAVER    = F
HEX      = F
HCOEF    = F
REACTING = F
INERTIA  = F
CONDX    = F
TWOD     = F
PRINTI   = F
ROTATION = F
BUOYANCY = F
HRATE    = T
INVAL    = F
MSORCE   = F
MOVBND   = T
TPA      = F
VARGEO   = T
TVM      = F
SHEAR    = F
PRNTIN   = F
PRNTADD  = T
ADDPROP  = F
PRESS    = F
INSUC    = F
VARROT   = F
NORMAL   = F
SECONDL  = T
CONJUG   = F
NRSOLVT  = F

```

```

NNODES = 2
NINT    = 2
NBR     = 1
NF      = 1
NVAR    = 5
NHREF   = 2

```

```

FLUIDS: N2

```

BOUNDARY NODES

```

NODE      P          T          RHO          AREA
          (PSI)      (F)        (LBM/FT^3)   (IN^2)
      ISTEP = 1      TAU = 0.10000E-03

```

BOUNDARY NODES

```

NODE      P (PSI)    TF (F)      Z (COMP)    RHO          QUALITY          (LBM/FT^3)

```

SOLUTION
INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
1	0.1471E+02	0.7510E+02	0.1000E+01	0.7182E-01	0.1028E-02	0.1000E+01
2	0.1471E+02	0.7510E+02	0.1000E+01	0.7182E-01	0.1028E-02	0.1000E+01

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
1	0.1975E+03	0.1054E+01	0.1199E-04	0.4154E-05	0.2487E+00	0.1401E+01
2	0.1975E+03	0.1054E+01	0.1199E-04	0.4154E-05	0.2487E+00	0.1401E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/ (LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO. BTU/ (R-SEC)	ENTROPY GEN. LBF-FT/SEC	LOST WORK
12	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00	0.000E+00

***** TOTAL ENTROPY GENERATION = 0.000E+00 BTU/ (R-SEC) *****

**** TOTAL WORK LOST = 0.000E+00 HP *****

:
:
:
:

ISTEP = 250 TAU = 0.25000E-01

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
------	---------	--------	----------	-------------------	---------

SOLUTION
INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
1	0.2235E+03	0.6933E+03	0.1007E+01	0.5024E+00	0.1028E-02	0.1000E+01
2	0.2235E+03	0.6933E+03	0.1007E+01	0.5024E+00	0.1028E-02	0.1000E+01

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
1	0.3536E+03	0.1054E+01	0.2052E-04	0.7338E-05	0.2597E+00	0.1382E+01
2	0.3536E+03	0.1054E+01	0.2052E-04	0.7338E-05	0.2597E+00	0.1382E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/ (LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/ (R-SEC)	LOST WORK LBF-FT/SEC
(12	0.125E+22	0.000E+00	0.620E-23	0.251E-21	0.154E-17	0.149E-24	0.658E-54	0.590E-48

***** TOTAL ENTROPY GENERATION = 0.658E-54 BTU/ (R-SEC) *****

**** TOTAL WORK LOST = 0.107E-50 HP *****

AT ISTEP= 250
WARNING! CHKGASP: T out of fluid property range at node 1

AT ISTEP= 250
WARNING! CHKGASP: T out of fluid property range at node 2

```

:
:
:
:

      ISTEP = 500      TAU = 0.50000E-01
BOUNDARY NODES
      NODE      P (PSI)      TF (F)      Z (COMP)      RHO
                        (LBM/FT^3)      QUALITY

SOLUTION
INTERNAL NODES
      NODE      P (PSI)      TF (F)      Z      RHO
                        (LBM/FT^3)      EM (LBM)      QUALITY
1      0.1470E+02      0.7501E+02      0.1000E+01      0.7179E-01      0.1028E-02      0.1000E+01
2      0.1470E+02      0.7501E+02      0.1000E+01      0.7179E-01      0.1028E-02      0.1000E+01

      NODE      H      ENTROPY      EMU      COND      CP      GAMA
              BTU/LB      BTU/LB-R      LBM/FT-SEC      BTU/FT-S-R      BTU/LB-R
1      0.1975E+03      0.1054E+01      0.1199E-04      0.4153E-05      0.2487E+00      0.1401E+01
2      0.1975E+03      0.1054E+01      0.1199E-04      0.4153E-05      0.2487E+00      0.1401E+01

      BRANCHES
BRANCH      KFACTOR      DELP      FLOW RATE      VELOCITY      REYN. NO.      MACH NO.      ENTROPY GEN.      LOST WORK
              (LBF-S^2/      (PSI)      (LBM/SEC)      (FT/SEC)      (LBM-FT) ^2)      BTU/ (R-SEC)      LBF-FT/SEC
12      0.510E+22      0.000E+00      0.620E-23      0.176E-20      0.263E-17      0.152E-23      0.406E-52      0.169E-46

      ***** TOTAL ENTROPY GENERATION =      0.406E-52 BTU/ (R-SEC) *****
      ***** TOTAL WORK LOST =      0.307E-49 HP *****

.....
TIME OF ANALYSIS WAS 1.09156960000000 SECS
.....

```



APPENDIX M—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 10

Power Balancing of a Turbopump Assembly

Contents	Page
Example 10 Input File	55
Example 10 Pump Characteristic Data File	58
Example 10 Output File	59

```

GFSSP VERSION
503
GFSSP INSTALLATION PATH
C:\Program Files\GFSSP\
ANALYST
PS
INPUT DATA FILE NAME
C:\Program Files\GFSSP\Examples\Ex10\Ex10.dat
OUTPUT FILE NAME
Ex10.out
TITLE
Power Balancing of a Turbopump Assembly
USETUP
F
DENCON      GRAVITY      ENERGY      MIXTURE      THRUST      STEADY      TRANSV      SAVER
F            F            T            F            F            T            F            F
HEX          HCOEF        REACTING      INERTIA      CONDX        ADDPROP      PRINTI      ROTATION
T            T            F            F            F            F            F            F
BUOYANCY     HRATE          INVAL        MSORCE       MOVBNB      TPA          VARGEO      TVM
F            T            F            F            F            T            F            F
SHEAR        PRNTIN        PRNTADD      OPVALVE      TRANSQ      CONJUG       RADIAT      WINPLOT
F            F            T            F            F            F            F            T
PRESS        INSUC        VARROT       CYCLIC       CHKVALS     WINFILE      DALTON
F            F            F            F            F            T            F
NORMAL       SIMUL        SECONDL      NRSOLVT
F            T            F            F
NNODES       NINT         NBR          NF
20           17          20           1
RELAXK       RELAXD       RELAXH       CC            NITER
1            0.5        1            0.0001       500
NFLUID(I), I = 1, NF
10
NODE         INDEX      DESCRIPTION
1            2          "Node 1"
2            1          "Node 2"
3            1          "Node 3"
4            1          "Node 4"
5            1          "Node 5"
6            1          "Node 6"
7            1          "Node 7"
8            1          "Node 8"
9            1          "Node 9"
10           1          "Node 10"
11           1          "Node 11"
12           1          "Node 12"
13           1          "Node 13"
14           1          "Node 14"
15           1          "Node 15"
16           1          "Node 16"
17           2          "Node 17"
18           1          "Node 18"
19           1          "Node 19"
20           2          "Node 20"
NODE         PRES (PSI)    TEMP (DEGF)    MASS SOURC    HEAT SOURC    THRST AREA    CONCENTRATION
1            60          -419          0             0             0
2            25          -419          0             0             0
3            25          -419          0             0             0
4            25          -419          0             0             0
5            25          -419          0             0             0
6            25          -419          0             0             0
7            25          -419          0             0             0
8            25          -419          0             0             0
9            25          -419          0             0             0
10           25          -419          0             0             0
11           25          -419          0             0             0
12           25          -419          0             0             0
13           25          -419          0             0             0
14           25          -419          0             0             0
15           25          -419          0             0             0
16           25          -419          0             0             0
17           14.7        80           0             0             0

```


18	25	-419	0	200	0
19	25	-419	0	0	0
20	14.7	80	0	0	0

INODE	NUMBR	NAMEBR			
2	2	12	23		
3	2	23	34		
4	3	34	45	46	
5	2	45	57		
6	2	46	68		
7	2	57	78		
8	3	78	68	89	
9	2	89	910		
10	2	910	1011		
11	2	1011	1112		
12	2	1112	1213		
13	2	1213	1314		
14	2	1314	1415		
15	2	1415	1516		
16	3	1516	1617	1618	
18	2	1618	1819		
19	2	1819	1920		

BRANCH	UPNODE	DNNODE	OPTION	DESCRIPTION
12	1	2	16	"CV 12"
23	2	3	15	"Pump 23"
34	3	4	1	"Pipe 34"
45	4	5	1	"Pipe 45"
57	5	7	1	"Pipe 57"
78	7	8	1	"Pipe 78"
46	4	6	1	"Pipe 46"
68	6	8	1	"Pipe 68"
89	8	9	16	"CV 89"
910	9	10	1	"Pipe 910"
1011	10	11	1	"Pipe 1011"
1112	11	12	16	"CV 1112"
1213	12	13	15	"Pump 1213"
1314	13	14	1	"Pipe 1314"
1415	14	15	1	"Pipe 1415"
1516	15	16	1	"Pipe 1516"
1617	16	17	16	"CV 1617"
1618	16	18	16	"CV 1618"
1819	18	19	1	"Pipe 1819"
1920	19	20	1	"Pipe 1920"

BRANCH	OPTION	-16	CV	AREA			
12			2.877	0.19635			
BRANCH	OPTION	-15	HORSEPOWER	EFFICIENCY	AREA		
23			0	0.8	0.12112		
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE	AREA
34			100	0.3927	0.0025	0	0.12112
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE	AREA
45			100	0.3927	0.0025	0	0.12112
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE	AREA
57			100	0.3927	0.0025	0	0.12112
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE	AREA
78			100	0.3927	0.0025	0	0.12112
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE	AREA
46			100	0.3927	0.0025	0	0.12112
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE	AREA
68			100	0.3927	0.0025	0	0.12112
BRANCH	OPTION	-16	CV	AREA			
89			3.554	0.19635			
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE	AREA
910			100	0.3927	0.0025	0	0.12112
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE	AREA
1011			100	0.3927	0.0025	0	0.12112
BRANCH	OPTION	-16	CV	AREA			
1112			3.554	0.19635			
BRANCH	OPTION	-15	HORSEPOWER	EFFICIENCY	AREA		
1213			0	1	0.019635		
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE	AREA
1314			100	0.3927	0.0025	0	0.12112

BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE	AREA
1415			100	0.3927	0.0025	0	0.12112
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE	AREA
1516			100	0.3927	0.0025	0	0.12112
BRANCH	OPTION	-16	CV	AREA			
1617			0.00354	0.01			
BRANCH	OPTION	-16	CV	AREA			
1618			3.554	0.19635			
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE	AREA
1819			100	0.3927	0.0025	0	0.12112
BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE	AREA
1920			100	0.3927	0.0025	0	0.12112

NUMBER OF HEAT EXCHANGERS
2

IBRHOT	IBRCLD	ITYPHX	ARHOT	ARCOLD	UA	HEXEFF
1415	57	2	0	0	0	0.8
1819	910	2	0	0	0	0.9

NUMBER OF TURBOPUMP ASSEMBLY IN THE CIRCUIT
1

IBRPMP	IBRTRB	SPEED(RPM)	EFFTURB	DIATRB	PSITRD
23	1213	80000	0.5	3.435	0.4

PUMP CHARACTERISTICS CURVE DATA FILE
ex11pmp23.dat

Example 10 Pump Characteristic Data File
EX11PMP23.DAT

```
18
0.000      8.680E-06      0.000
3.035E-05  8.971E-06      8.8724E-10
6.071E-05  9.190E-06      9.7065E-10
9.106E-05  9.341E-06      1.0804E-09
1.214E-04  9.436E-06      1.2166E-09
1.518E-04  9.486E-06      1.3393E-09
1.821E-04  9.486E-06      1.4570E-09
2.125E-04  9.445E-06      1.5644E-09
2.428E-04  9.372E-06      1.6733E-09
2.732E-04  9.263E-06      1.7872E-09
3.035E-04  9.117E-06      1.9105E-09
3.339E-04  8.935E-06      2.0558E-09
3.643E-04  8.753E-06      2.2161E-09
3.718E-04  8.689E-06      2.2698E-09
3.749E-04  8.625E-06      2.2869E-09
3.794E-04  8.479E-06      2.3215E-09
3.807E-04  8.388E-06      2.3281E-09
3.810E-04  0.000E+00      0.000
```

```

.....
      G F S S P (Version 5.0)
      Generalized Fluid System Simulation Program
          September, 2006
      Developed by NASA/Marshall Space Flight Center
      Copyright © by Marshall Space Flight Center

```

```

      A generalized computer program to calculate flow
      rates, pressures, temperatures and concentrations
      in a flow network.
.....

```

```

TITLE      :Power Balancing of a Turbopump Assembly
ANALYST    :PS\
FILEIN     :C:\Program Files\GFSSP\Examples\Ex11\Ex11.dat\
FILEOUT    :Ex11.out\

```

LOGICAL VARIABLES

```

DENCON      = F
GRAVITY     = F
ENERGY      = T
MIXTURE     = F
THRUST      = F
STEADY      = T
TRANSV      = F
SAVER       = F
HEX         = T
HCOEF       = T
REACTING    = F
INERTIA     = F
CONDX       = F
TWOD        = F
PRINTI      = F
ROTATION    = F
BUOYANCY    = F
HRATE       = T
INVAL       = F
MSORCE      = F
MOVBND      = F
TPA         = T
VARGEO      = F
TVM         = F
SHEAR       = F
PRNTIN      = F
PRNTADD     = T
ADDPROP     = F
PRESS       = F
INSUC       = F
VARROT      = F
NORMAL      = F
SECONDL     = F
CONJUG      = F
NRSOLVT     = F

```

```

NNODES      = 20
NINT        = 17
NBR         = 20
NF          = 1
NVAR        = 37
NHREF       = 2

```

FLUIDS: H2

BOUNDARY NODES

NODE	P (PSI)	T (F)	RHO (LBM/FT^3)	AREA (IN^2)
1	0.6000E+02	-0.4190E+03	0.4267E+01	0.0000E+00
17	0.1470E+02	0.8000E+02	0.5112E-02	0.0000E+00
20	0.1470E+02	0.8000E+02	0.5112E-02	0.0000E+00

```

1
IBRPMP      IBTRB  SPEED(RPM)      ETATRB      PSITR      TORQUE(LB-IN)  HPOWER
 23 1213    0.800E+05      0.000E+00    0.000E+00    0.000E+00    0.000E+00
SOLUTION
INTERNAL NODES
NODE      P (PSI)      TF (F)      Z      RHO      EM (LBM)      QUALITY
              (LBM/FT^3)
 2      0.5542E+02    -0.4190E+03    0.6012E-01    0.4262E+01    0.0000E+00    0.0000E+00
 3      0.1790E+04    -0.4074E+03    0.1370E+01    0.4700E+01    0.0000E+00    0.0000E+00
 4      0.1780E+04    -0.4072E+03    0.1361E+01    0.4693E+01    0.0000E+00    0.0000E+00
 5      0.1778E+04    -0.4072E+03    0.1360E+01    0.4692E+01    0.0000E+00    0.0000E+00
 6      0.1775E+04    -0.4072E+03    0.1357E+01    0.4690E+01    0.0000E+00    0.0000E+00
 7      0.1777E+04    -0.1462E+03    0.1091E+01    0.9764E+00    0.0000E+00    0.1000E+01
 8      0.1771E+04    -0.3066E+03    0.1063E+01    0.2046E+01    0.0000E+00    0.1000E+01
 9      0.1765E+04    -0.3066E+03    0.1062E+01    0.2040E+01    0.0000E+00    0.1000E+01
10      0.1741E+04     0.1474E+03    0.1065E+01    0.5061E+00    0.0000E+00    0.1000E+01
11      0.1645E+04     0.1478E+03    0.1061E+01    0.4794E+00    0.0000E+00    0.1000E+01
12      0.1618E+04     0.1479E+03    0.1060E+01    0.4719E+00    0.0000E+00    0.1000E+01
13      0.1078E+04     0.9029E+02    0.1043E+01    0.3531E+00    0.0000E+00    0.1000E+01
14      0.9403E+03     0.9075E+02    0.1038E+01    0.3093E+00    0.0000E+00    0.1000E+01
15      0.7830E+03    -0.3869E+01    0.1034E+01    0.3120E+00    0.0000E+00    0.1000E+01
16      0.6272E+03    -0.3550E+01    0.1028E+01    0.2514E+00    0.0000E+00    0.1000E+01
18      0.5766E+03     0.2489E+03    0.1020E+01    0.1498E+00    0.0000E+00    0.1000E+01
19      0.2539E+03    -0.2250E+03    0.1008E+01    0.2016E+00    0.0000E+00    0.1000E+01

NODE      H      ENTROPY      EMU      COND      CP      GAMA
          BTU/LB      BTU/LB-R      LBM/FT-SEC      BTU/FT-S-R      BTU/LB-R
 2      -0.9824E+02    0.6868E+01    0.7636E-05    0.1636E-04    0.2562E+01    0.1935E+01
 3      -0.2292E+02    0.6868E+01    0.9984E-05    0.2255E-04    0.2462E+01    0.1536E+01
 4      -0.2292E+02    0.6868E+01    0.9926E-05    0.2252E-04    0.2469E+01    0.1539E+01
 5      -0.2292E+02    0.6868E+01    0.9919E-05    0.2251E-04    0.2469E+01    0.1540E+01
 6      -0.2292E+02    0.6868E+01    0.9901E-05    0.2251E-04    0.2472E+01    0.1541E+01
 7      0.9610E+03     0.6868E+01    0.4449E-05    0.2579E-04    0.4051E+01    0.1394E+01
 8      0.3228E+03     0.6868E+01    0.3649E-05    0.1629E-04    0.3731E+01    0.1813E+01
 9      0.3228E+03     0.6868E+01    0.3644E-05    0.1627E-04    0.3730E+01    0.1813E+01
10      0.2065E+04     0.6868E+01    0.6567E-05    0.3408E-04    0.3539E+01    0.1411E+01
11      0.2065E+04     0.6868E+01    0.6560E-05    0.3405E-04    0.3536E+01    0.1410E+01
12      0.2065E+04     0.6868E+01    0.6558E-05    0.3405E-04    0.3536E+01    0.1410E+01
13      0.1854E+04     0.6868E+01    0.6093E-05    0.3192E-04    0.3576E+01    0.1401E+01
14      0.1854E+04     0.6868E+01    0.6081E-05    0.3189E-04    0.3571E+01    0.1399E+01
15      0.1508E+04     0.6868E+01    0.5358E-05    0.2852E-04    0.3715E+01    0.1382E+01
16      0.1508E+04     0.6868E+01    0.5339E-05    0.2848E-04    0.3706E+01    0.1379E+01
18      0.2404E+04     0.6868E+01    0.7151E-05    0.3681E-04    0.3497E+01    0.1400E+01
19      0.6558E+03     0.6868E+01    0.3402E-05    0.1808E-04    0.3794E+01    0.1381E+01

```

BRANCHES

BRANCH	KFACTOR (LBF-S ² / (LBM-FT) ²)	DELTA (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.132E+05	0.458E+01	0.224E+00	0.385E+02	0.892E+06	0.277E-01	0.110E-02	0.346E+02
23	0.000E+00	-0.173E+04	0.224E+00	0.625E+02	0.114E+07	0.448E-01	0.000E+00	0.000E+00
34	0.298E+05	0.104E+02	0.224E+00	0.566E+02	0.872E+06	0.403E-01	0.175E-02	0.712E+02
45	0.302E+05	0.130E+01	0.787E-01	0.199E+02	0.308E+06	0.141E-01	0.770E-04	0.314E+01
57	0.303E+05	0.130E+01	0.787E-01	0.199E+02	0.309E+06	0.141E-01	0.770E-04	0.314E+01
78	0.144E+06	0.618E+01	0.787E-01	0.958E+02	0.688E+06	0.292E-01	0.294E-03	0.717E+02
46	0.300E+05	0.439E+01	0.145E+00	0.368E+02	0.569E+06	0.261E-01	0.480E-03	0.196E+02
68	0.300E+05	0.439E+01	0.145E+00	0.368E+02	0.571E+06	0.261E-01	0.480E-03	0.196E+02
89	0.180E+05	0.626E+01	0.224E+00	0.803E+02	0.187E+07	0.307E-01	0.829E-03	0.987E+02
910	0.684E+05	0.238E+02	0.224E+00	0.130E+03	0.239E+07	0.499E-01	0.316E-02	0.376E+03
1011	0.276E+06	0.962E+02	0.224E+00	0.526E+03	0.133E+07	0.114E+00	0.130E-01	0.613E+04
1112	0.768E+05	0.267E+02	0.224E+00	0.343E+03	0.104E+07	0.745E-01	0.380E-02	0.180E+04
1213	0.000E+00	0.540E+03	0.224E+00	0.348E+04	0.330E+07	0.757E+00	0.000E+00	0.000E+00
1314	0.396E+06	0.138E+03	0.224E+00	0.754E+03	0.143E+07	0.173E+00	0.294E-01	0.126E+05
1415	0.452E+06	0.157E+03	0.224E+00	0.861E+03	0.143E+07	0.197E+00	0.383E-01	0.164E+05
1516	0.448E+06	0.156E+03	0.224E+00	0.853E+03	0.163E+07	0.216E+00	0.454E-01	0.161E+05
1617	0.148E+12	0.613E+03	0.773E-03	0.443E+02	0.196E+05	0.112E-01	0.764E-03	0.271E+03
1618	0.146E+06	0.506E+02	0.223E+00	0.651E+03	0.128E+07	0.165E+00	0.182E-01	0.647E+04
1819	0.933E+06	0.323E+03	0.223E+00	0.177E+04	0.121E+07	0.358E+00	0.125E+00	0.692E+05
1920	0.692E+06	0.239E+03	0.223E+00	0.132E+04	0.255E+07	0.466E+00	0.209E+00	0.381E+05

1

IBRPM	IBRTRB	SPEED (RPM)	ETATRB	PSITR	TORQUE (LB-IN)	HPOWER
23	1213	0.800E+05	0.578E+00	0.269E+00	0.511E+02	0.649E+02

TIME OF ANALYSIS WAS 0.510734400000000 SECS



APPENDIX N—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 11

Steady State & Transient Conduction Through a Circular Rod, with Convection

<u>Contents</u>	<u>Page</u>
Example 11 Input File	63
Example 11 Property Files	65
Example 11 Output File	66

```

GFSSP VERSION
503
GFSSP INSTALLATION PATH
C:\Program Files\GFSSP\
ANALYST
Alok Majumdar
INPUT DATA FILE NAME
C:\Program Files\GFSSP\Examples\Ex11\Ex11.dat
OUTPUT FILE NAME
Ex11.out
TITLE
Steady State & Transient Conduction Through a Circular Rod, With Convection
USERSETUP
F
DENCON      GRAVITY      ENERGY      MIXTURE      THRUST      STEADY      TRANSV      SAVER
F            F            T            F            F            T            F            F
HEX          HCOEF        REACTING     INERTIA      CONDX       ADDPROP     PRINTI      ROTATION
F            F            F            F            F            F            T            F
BUOYANCY     HRATE          INVAL       MSORCE       MOVBNB      TPA         VARGEO      TVM
F            T            F            F            F            F            F            F
SHEAR        PRNTIN        PRNTADD     OPVALVE      TRANSQ      CONJUG      RADIAT      WINPLOT
F            T            T            F            F            T            F            T
PRESS        INSUC        VARROT      CYCLIC       CHKVALS     WINFILE     DALTON
F            F            F            F            F            F            F
NORMAL       SIMUL        SECONDL     NRSOLVT
F            T            F            F
NNODES       NINT         NBR         NF
4            2            3            1
RELAXK       RELAXD       RELAXH      CC            NITER
1            0.5          1            0.0001       500
NFLUID(I), I = 1, NF
11
NODE      INDEX  DESCRIPTION
11        2      "Node 11"
12        1      "Node 12"
13        1      "Node 13"
14        2      "Node 14"
NODE      PRES  (PSI)    TEMP (DEGF)    MASS SOURC     HEAT SOURC     THRST AREA     CONCENTRATION
11        50          70          0              0              0
12        14.7        60          0              0              0
13        14.7        60          0              0              0
14        45          70          0              0              0
INODE      NUMBR  NAMEBR
12         2      1112    1213
13         2      1213    1314
BRANCH     UPNODE  DNNODE     OPTION         DESCRIPTION
1112       11      12         1              "Pipe 1112"
1213       12      13         1              "Pipe 1213"
1314       13      14         1              "Pipe 1314"

BRANCH     OPTION -1    LENGTH    DIA      EPSD      ANGLE      AREA
1112       0.1         1.73      0         0         2.3506
BRANCH     OPTION -1    LENGTH    DIA      EPSD      ANGLE      AREA
1213       12         1.73      0         0         2.3506
BRANCH     OPTION -1    LENGTH    DIA      EPSD      ANGLE      AREA
1314       12         1.73      0         0         2.3506
NSOLID     NAMB      NSSC      NSFC      NSAC      NSSR
8          2         7         8         2         0
NODESL     MATRL    SMASS     TS        NUMSS     NUMSF     NUMSA     NUMSSR     DESCRIPTION
2          41      1.00000  70.00000  1         1         1         0          "S Node 2"
NAMESS
23
NAMESEF
122
NAMESEA
12
3          41      1.00000  70.00000  2         1         0         0          "S Node 3"
NAMESS
23      34

```


NAMESF								
123								
4	41	1.00000	70.00000	2	1	0	0	"S Node 4"
NAMESS								
34	45							
NAMESF								
124								
5	41	1.00000	70.00000	2	1	0	0	"S Node 5"
NAMESS								
45	56							
NAMESF								
125								
6	41	1.00000	70.00000	2	1	0	0	"S Node 6"
NAMESS								
56	67							
NAMESF								
136								
7	41	1.00000	70.00000	2	1	0	0	"S Node 7"
NAMESS								
67	78							
NAMESF								
137								
8	41	1.00000	70.00000	2	1	0	0	"S Node 8"
NAMESS								
78	89							
NAMESF								
138								
9	41	1.00000	70.00000	1	1	1	0	"S Node 9"
NAMESS								
89								
NAMESF								
139								
NAMESA								
910								

NODEAM		TAMB		DESCRIPTION				
1		32.00000		"A Node 1"				
10		212.00000		"A Node 10"				
ICONSS	ICNSI	ICNSJ	ARCSIJ	DISTSIJ	DESCRIPTION			
23	2	3	3.14159	3.00000	"Conductor 23"			
34	3	4	3.14159	3.00000	"Conductor 34"			
45	4	5	3.14159	3.00000	"Conductor 45"			
56	5	6	3.14159	3.00000	"Conductor 56"			
67	6	7	3.14159	3.00000	"Conductor 67"			
78	7	8	3.14159	3.00000	"Conductor 78"			
89	8	9	3.14159	3.00000	"Conductor 89"			
ICONSF	ICS	ICF	MODEL	ARSF	HCSF	EMSFS	EMSFF	DESCRIPTION
122	2	12	0	1.88500e+01	3.17000e-04	0.00000e+00	0.00000e+00	"Convection 122"
123	3	12	0	1.88500e+01	3.17000e-04	0.00000e+00	0.00000e+00	"Convection 123"
124	4	12	0	1.88500e+01	3.17000e-04	0.00000e+00	0.00000e+00	"Convection 124"
125	5	12	0	1.88500e+01	3.17000e-04	0.00000e+00	0.00000e+00	"Convection 125"
136	6	13	0	1.88500e+01	3.17000e-04	0.00000e+00	0.00000e+00	"Convection 136"
137	7	13	0	1.88500e+01	3.17000e-04	0.00000e+00	0.00000e+00	"Convection 137"
138	8	13	0	1.88500e+01	3.17000e-04	0.00000e+00	0.00000e+00	"Convection 138"
139	9	13	0	1.88500e+01	3.17000e-04	0.00000e+00	0.00000e+00	"Convection 139"
ICONSA	ICSAS	ICSAA	ARSA	HCSA	EMSAS	EMSAA	DESCRIPTION	
12	2	1	3.14159e+00	2.00000e-02	0.00000e+00	0.00000e+00	"Convection 12"	
910	9	10	3.14159e+00	2.00000e-02	0.00000e+00	0.00000e+00	"Convection 910"	

EXAMPLE 11 PROPERTY FILES

USER1CP.PRP

```
2
0      0.1981
1000   0.1981
```

USER1K.PRP

```
2
0      0.002611
1000   0.002611
```

```

.....
      G F S S P (Version 5.0)
    Generalized Fluid System Simulation Program
      September, 2006
    Developed by NASA/Marshall Space Flight Center
    Copyright © by Marshall Space Flight Center

```

```

A generalized computer program to calculate flow
rates, pressures, temperatures and concentrations
in a flow network.
.....

```

```

TITLE   :Steady State & Transient Conduction Through a Circular Rod, With Convection
ANALYST :Alok Majumdar
FILEIN  :C:\Program Files\GFSSP\Examples\Ex11\Ex11.dat
FILEOUT :Ex11.out

```

LOGICAL VARIABLES

```

DENCON   = F
GRAVITY  = F
ENERGY   = T
MIXTURE  = F
THRUST   = F
STEADY   = T
TRANSV   = F
SAVER    = F
HEX      = F
HCOEF    = F
REACTING = F
INERTIA  = F
CONDX    = F
TWOD     = F
PRINTI   = T
ROTATION = F
BUOYANCY = F
HRATE    = T
INVAL    = F
MSORCE   = F
MOVBND   = F
TPA      = F
VARGEO   = F
TVM      = F
SHEAR    = F
PRNTIN   = T
PRNTADD  = T
ADDPROP  = F
PRESS    = F
INSUC    = F
VARROT   = F
NORMAL   = F
SECONDL  = F
CONJUG   = T
NRSOLVT  = F

```

```

NNODES   = 4
NINT      = 2
NBR       = 3
NF        = 1
NVAR      = 5
NHREF     = 2

```

```

FLUIDS: H2O

```

```

BOUNDARY NODES
  NODE      P          T          RHO          AREA
          (PSI)      (F)      (LBM/FT^3)  (IN^2)
  11      0.5000E+02  0.7000E+02  0.6231E+02  0.0000E+00
  14      0.4500E+02  0.7000E+02  0.6231E+02  0.0000E+00

INPUT SPECIFICATIONS FOR INTERNAL NODES
  NODE      AREA      MASS      HEAT
          (IN^2)    (LBM/S)  (BTU/S)
  12      0.0000E+00  0.0000E+00  0.0000E+00
  13      0.0000E+00  0.0000E+00  0.0000E+00

BRANCH      UPNODE      DNNODE      OPTION
  1112      11          12          1
  1213      12          13          1
  1314      13          14          1
BRANCH OPTION -1:  LENGTH, DIA, EPSD, ANGLE, AREA
  1112      0.100E+00  0.173E+01  0.000E+00  0.000E+00  0.235E+01
BRANCH OPTION -1:  LENGTH, DIA, EPSD, ANGLE, AREA
  1213      0.120E+02  0.173E+01  0.000E+00  0.000E+00  0.235E+01
BRANCH OPTION -1:  LENGTH, DIA, EPSD, ANGLE, AREA
  1314      0.120E+02  0.173E+01  0.000E+00  0.000E+00  0.235E+01

INITIAL GUESS FOR INTERNAL NODES
  NODE      P (PSI)      TF (F)      Z (COMP)      RHO      QUALITY
          (LBM/FT^3)
  12      0.1470E+02  0.6000E+02  0.7616E-03  0.6237E+02  0.0000E+00
  13      0.1470E+02  0.6000E+02  0.7616E-03  0.6237E+02  0.0000E+00

TRIAL SOLUTION
  BRANCH  DELP (PSI)      FLOWRATE (LBM/SEC)
  1112    0.0000 0.0100
  1213    0.0000 0.0100
  1314    0.0000 0.0100

CONJUGATE HEAT TRANSFER
  NSOLIDX = 8
  NAMB     = 2
  NSSC     = 7
  NSFC     = 8
  NSAC     = 2
  NSSR     = 0
  NODESL   MATRL   SMASS   TS      NUMSS   NUMSF   NUMSA
    2      41      1.0000  70.0000  1        1        1
  NAMESS
    23
  NAMESF
    122
  NAMESA
    12
  NODESL   MATRL   SMASS   TS      NUMSS   NUMSF   NUMSA
    3      41      1.0000  70.0000  2        1        0
  NAMESS
    23
  NAMESF
    123
  NODESL   MATRL   SMASS   TS      NUMSS   NUMSF   NUMSA
    4      41      1.0000  70.0000  2        1        0
  NAMESS
    34
  NAMESF
    124
  NODESL   MATRL   SMASS   TS      NUMSS   NUMSF   NUMSA
    5      41      1.0000  70.0000  2        1        0
  NAMESS
    45
  NAMESF
    125
  NODESL   MATRL   SMASS   TS      NUMSS   NUMSF   NUMSA
    6      41      1.0000  70.0000  2        1        0

```

NAMESS						
56	67					
NAMESF						
136						
NODESL	MATRL	SMASS	TS	NUMSS	NUMSF	NUMSA
7	41	1.0000	70.0000	2	1	0
NAMESS						
67	78					
NAMESF						
137						
NODESL	MATRL	SMASS	TS	NUMSS	NUMSF	NUMSA
8	41	1.0000	70.0000	2	1	0
NAMESS						
78	89					
NAMESF						
138						
NODESL	MATRL	SMASS	TS	NUMSS	NUMSF	NUMSA
9	41	1.0000	70.0000	1	1	1
NAMESS						
89						
NAMESF						
139						
NAMESEA						
910						
NODEAM TAMB						
1	32.0000					
10	212.0000					
ICONSS	ICNSI	ICNSJ	ARCSIJ	DISTSIJ		
23	2	3	3.1416	3.0000		
34	3	4	3.1416	3.0000		
45	4	5	3.1416	3.0000		
56	5	6	3.1416	3.0000		
67	6	7	3.1416	3.0000		
78	7	8	3.1416	3.0000		
89	8	9	3.1416	3.0000		
ICONSF	ICS	ICF	ARSF	EMSFS		
122	2	12	18.8500	0.0000	0.0000	
123	3	12	18.8500	0.0000	0.0000	
124	4	12	18.8500	0.0000	0.0000	
125	5	12	18.8500	0.0000	0.0000	
136	6	13	18.8500	0.0000	0.0000	
137	7	13	18.8500	0.0000	0.0000	
138	8	13	18.8500	0.0000	0.0000	
139	9	13	18.8500	0.0000	0.0000	
ICONSA	ICSAS	ICSAA	ARSA	HCSA	EMSAS	EMSAA
12	2	1	0.3142E+01	0.2000E-01	0.0000E+00	0.0000E+00
910	9	10	0.3142E+01	0.2000E-01	0.0000E+00	0.0000E+00
SOLUTION						
INTERNAL NODES						
NODE	P (PSI)	TF (F)	Z (LBM/FT^3)	RHO	EM (LBM)	QUALITY
12	0.4998E+02	0.7000E+02	0.2543E-02	0.6231E+02	0.0000E+00	0.0000E+00
13	0.4749E+02	0.7001E+02	0.2416E-02	0.6231E+02	0.0000E+00	0.0000E+00
NODE	H	ENTROPY	EMU	COND	CP	GAMA
	BTU/LB	BTU/LB-R	LBM/FT-SEC	BTU/FT-S-R	BTU/LB-R	
12	0.3816E+02	0.5542E-01	0.6564E-03	0.9662E-04	0.9998E+00	0.1007E+01
13	0.3816E+02	0.5542E-01	0.6563E-03	0.9662E-04	0.9998E+00	0.1007E+01

BRANCHES

BRANCH	KFACTOR (LBF-S ² / (LBM-FT) ²)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
1112	0.639E-03	0.207E-01	0.684E+02	0.672E+02	0.920E+06	0.554E-01	0.795E-05	0.328E+01
1213	0.767E-01	0.249E+01	0.684E+02	0.672E+02	0.920E+06	0.554E-01	0.954E-03	0.393E+03
1314	0.767E-01	0.249E+01	0.684E+02	0.673E+02	0.920E+06	0.555E-01	0.954E-03	0.393E+03

SOLID NODES

NODESL	CPSLD BTU/LB F	TS F
2	0.000E+00	0.423E+02
3	0.000E+00	0.569E+02
4	0.000E+00	0.691E+02
5	0.000E+00	0.812E+02
6	0.000E+00	0.954E+02
7	0.000E+00	0.114E+03
8	0.000E+00	0.141E+03
9	0.000E+00	0.181E+03

SOLID TO SOLID CONDUCTOR

ICONSS	CONDKIJ BTU/S FT F	QDOTSS BTU/S
23	0.261E-02	-0.333E-02
34	0.261E-02	-0.279E-02
45	0.261E-02	-0.276E-02
56	0.261E-02	-0.322E-02
67	0.261E-02	-0.428E-02
78	0.261E-02	-0.611E-02
89	0.261E-02	-0.906E-02

SOLID TO FLUID CONDUCTOR

ICONSF	QDOTSF BTU/S	HCSF BTU/SFT**2 F	HCSFR
122	-0.115E-02	0.317E-03	0.000E+00
123	-0.544E-03	0.317E-03	0.000E+00
124	-0.356E-04	0.317E-03	0.000E+00
125	0.466E-03	0.317E-03	0.000E+00
136	0.105E-02	0.317E-03	0.000E+00
137	0.183E-02	0.317E-03	0.000E+00
138	0.294E-02	0.317E-03	0.000E+00
139	0.459E-02	0.317E-03	0.000E+00

SOLID TO AMBIENT CONDUCTOR

ICONSA	QDOTSA BTU/S	HCSA BTU/S FT**2 F	HCSAR BTU/S FT**2 F
12	0.448E-02	0.200E-01	0.000E+00
910	-0.136E-01	0.200E-01	0.000E+00

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 10 ITERATIONS

TAU = 100000000.000000 ISTEP = 1

.....

TIME OF ANALYSIS WAS 0.13018720000000 SECS

.....



APPENDIX O—INPUT AND OUTPUT DATA FILES FROM EXAMPLE 12

Simulation of Fluid Transient Following Sudden Valve Closure

Contents	Page
Example 12 Input File	71
Example 12 History & Restart Files	73
Example 12 Output File (Partial)	74

```

GFSSP VERSION
503
GFSSP INSTALLATION PATH
C:\Program Files\GFSSP\
ANALYST
Alok Majumdar
INPUT DATA FILE NAME
C:\Program Files\GFSSP\Examples\Ex15\Ex15.dat
OUTPUT FILE NAME
Ex15.out
TITLE
Simulation of Fluid Transient Following Sudden Valve Closure
USETUP
F
DENCON      GRAVITY    ENERGY    MIXTURE    THRUST    STEADY    TRANSV    SAVER
F            F          T            F          F          F          T          F
HEX          HCOEF      REACTING    INERTIA    CONDX     ADDPROP    PRINTI    ROTATION
F            F          F            F          F          F          T          F
BOUYANCY     HRATE      INVAL      MSORCE     MOVBNB    TPA        VARGEO    TVM
F            T          T            F          F          F          F          F
SHEAR        PRNTIN     PRNTADD    OPVALVE    TRANSQ    CONJUG     RADIAT    WINPLOT
F            T          T            T          F          F          F          T
PRESS        INSUC     VARROT     CYCLIC     CHKVALS   WINFILE    DALTON
F            F          F            F          F          T          F
NORMAL       SIMUL      SECONDL    NRSOLVT
F            T          F            F
NNODES       NINT      NBR        NF
7            5          6          1
RELAXK       RELAXD     RELAXH     CC          NITER
1            0.5        1          0.0001      500
DTAU         TIMEF     TIMEL      NPSTEP      NPWSTEP
0.02         0          1          1           1
NFLUID(I), I = 1, NF
6
NODE         INDEX      DESCRIPTION
1            2          "Node 1"
2            1          "Node 2"
3            1          "Node 3"
4            1          "Node 4"
5            1          "Node 5"
6            1          "Node 6"
7            2          "Node 7"
NODE  PRES  (PSI)  TEMP (DEGF)  MASS  SOURC  HEAT  SOURC  THRST  AREA  NODE-VOLUME  CONCENTRATION
2      14.7      60          0          0          0          0          0
3      14.7      60          0          0          0          0          0
4      14.7      60          0          0          0          0          0
5      14.7      60          0          0          0          0          0
6      14.7      60          0          0          0          0          0
ex15hs1.dat
ex15hs7.dat
INODE        NUMBR      NAMEBR
2            2          12      23
3            2          23      34
4            2          34      45
5            2          45      56
6            2          56      67
BRANCH  UPNODE  DNNODE  OPTION  DESCRIPTION
12       1       2         1      "Pipe 12"
23       2       3         1      "Pipe 23"
34       3       4         1      "Pipe 34"
45       4       5         1      "Pipe 45"
56       5       6         1      "Pipe 56"
67       6       7         2      "Restrict 67"
BRANCH  OPTION  -1  LENGTH  DIA  EPSD  ANGLE  AREA
12       0      960  0.25   0     0     0.049087
BRANCH  OPTION  -1  LENGTH  DIA  EPSD  ANGLE  AREA
23       0      960  0.25   0     0     0.049087
BRANCH  OPTION  -1  LENGTH  DIA  EPSD  ANGLE  AREA
34       0      960  0.25   0     0     0.049087
BRANCH  OPTION  -1  LENGTH  DIA  EPSD  ANGLE  AREA
45       0      960  0.25   0     0     0.049087

```


BRANCH	OPTION	-1	LENGTH	DIA	EPSD	ANGLE	AREA
56			960	0.25	0	0	0.049087

BRANCH	OPTION	-2	FLOW COEFF	AREA
67			0.6	0.0491

INITIAL FLOWRATES IN BRANCHES FOR UNSTEADY FLOW

12	0
23	0
34	0
45	0
56	0
67	0

NUMBER OF CLOSING/OPENING VALVES IN THE CIRCUIT

1

BRANCH

67

FILE NAME

ex15v1v.dat

RESTART NODE INFORMATION FILE

FNDEX15.DAT

RESTART BRANCH INFORMATION FILE

FBREX15.DAT

EXAMPLE 12 HISTORY AND RESTART FILES

EX15HS1.DAT

```
2
0      500.0    -260.0    0.0
1000   500.0    -260.0    0.0
```

EX15HS7.DAT

```
2
0      450.0    -260.0    0.0
1000   450.0    -260.0    0.0
```

EX15VLV.DAT

```
7
0.00    0.0491
0.02    0.0164
0.04    0.00545
0.06    0.00182
0.08    0.00061
0.1     1.E-16
100     1.E-16
```

FNDEX15.DAT

NODE	P (PSF) EMU (LB/FT-S)	TF (R) Z R (LBF-FT/LB-R)	H (BTU/LB) EM (LB)	CONC RHO (LB/FT^3) CP (BTU/LB-R)	ENTROPY (BTU/LB-R)
2	70570.99	199.6258	77.07056	1.000000	
	64.96349	8.4011677E-05	0.1126991	48.28000	0.0000000E+00 0.4173057
1.524868					
3	69141.62	199.6527	77.07056	1.000000	
64.94235	8.3891122E-05	0.1104375	48.28000	0.0000000E+00	
0.4175506	1.524851				
4	67712.23	199.6797	77.07058	1.000000	
64.92119	8.3770668E-05	0.1081750	48.28000	0.0000000E+00	
0.4178011	1.524851				
5	66282.80	199.7065	77.07059	1.000000	
64.90001	8.3650339E-05	0.1059117	48.28000	0.0000000E+00	
0.4180055	1.524851				
6	64853.37	199.7332	77.07063	1.000000	
64.87878	8.3530074E-05	0.1036477	48.28000	0.0000000E+00	
0.4182283	1.524851				

FBREX15.DAT

BRANCH	AK	FLOWR (LB/S)	VEL (FT/S)
12	153259.8	9.6560813E-02	4.358272
23	153280.5	9.6560813E-02	4.360718
34	153282.9	9.6560813E-02	4.362138
45	153285.4	9.6560813E-02	4.363560
56	153287.8	9.6560813E-02	4.364984
67	5722.974	9.6560813E-02	4.369652

```

.....
      G F S S P (Version 5.0)
      Generalized Fluid System Simulation Program
      September, 2006
      Developed by NASA/Marshall Space Flight Center
      Copyright © by Marshall Space Flight Center

```

```

      A generalized computer program to calculate flow
      rates, pressures, temperatures and concentrations
      in a flow network.
.....

```

```

TITLE      :Simulation of Fluid Transient Following Sudden Valve Closure
ANALYST    :Alok Majumdar
FILEIN     :C:\Program Files\GFSSP\Examples\Ex12\Ex12.dat
FILEOUT    :Ex12.out
LOGICAL VARIABLES
DENCON     = F
GRAVITY    = F
ENERGY     = T
MIXTURE    = F
THRUST     = F
STEADY     = F
TRANSV     = T
SAVER      = F
HEX        = F
HCOEF      = F
REACTING   = F
INERTIA    = F
CONDX      = F
TWOD       = F
PRINTI     = T
ROTATION   = F
BUOYANCY   = F
HRATE      = T
INVAL      = T
MSORCE     = F
MOVBND     = F
TPA        = F
VARGEO     = F
TVM        = F
SHEAR      = F
PRNTIN     = T
PRNTADD    = T
ADDPROP    = F
PRESS      = F
INSUC      = F
VARROT     = F
NORMAL     = F
SECONDL    = F
CONJUG     = F
NRSOLVT    = F

NNODES     = 7
NINT       = 5
NBR        = 6
NF         = 1
NVAR       = 16
NHREF      = 2

```

```

FLUIDS: O2

```

```

BOUNDARY NODES
NODE   P          T          RHO          AREA
      (PSI)      (F)      (LBM/FT^3)  (IN^2)
  1    0.5000E+03  -0.2600E+03  0.6499E+02  0.0000E+00
  7    0.4500E+03  -0.2600E+03  0.6491E+02  0.0000E+00

```

INPUT SPECIFICATIONS FOR INTERNAL NODES

NODE	AREA (IN^2)	MASS (LBM/S)	HEAT (BTU/S)
2	0.0000E+00	0.0000E+00	0.0000E+00
3	0.0000E+00	0.0000E+00	0.0000E+00
4	0.0000E+00	0.0000E+00	0.0000E+00
5	0.0000E+00	0.0000E+00	0.0000E+00
6	0.0000E+00	0.0000E+00	0.0000E+00

BRANCH	UPNODE	DNNODE	OPTION
12	1	2	1
23	2	3	1
34	3	4	1
45	4	5	1
56	5	6	1
67	6	7	2

BRANCH	OPTION -1:	LENGTH, DIA,	EPSD, ANGLE, AREA	
12	0.960E+03	0.250E+00	0.000E+00 0.000E+00	0.491E-01
BRANCH	OPTION -1:	LENGTH, DIA,	EPSD, ANGLE, AREA	
3	0.960E+03	0.250E+00	0.000E+00 0.000E+00	0.491E-01
BRANCH	OPTION -1:	LENGTH, DIA,	EPSD, ANGLE, AREA	
34	0.960E+03	0.250E+00	0.000E+00 0.000E+00	0.491E-01
BRANCH	OPTION -1:	LENGTH, DIA,	EPSD, ANGLE, AREA	
45	0.960E+03	0.250E+00	0.000E+00 0.000E+00	0.491E-01
BRANCH	OPTION -1:	LENGTH, DIA,	EPSD, ANGLE, AREA	
56	0.960E+03	0.250E+00	0.000E+00 0.000E+00	0.491E-01
BRANCH	OPTION -2: FLOW COEF, AREA			
67	0.600E+00	0.164E-01		

INITIAL GUESS FOR INTERNAL NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
2	0.4901E+03	-0.2600E+03	0.1127E+00	0.6496E+02	0.0000E+00
3	0.4802E+03	-0.2599E+03	0.1104E+00	0.6494E+02	0.0000E+00
4	0.4702E+03	-0.2599E+03	0.1082E+00	0.6492E+02	0.0000E+00
5	0.4603E+03	-0.2599E+03	0.1059E+00	0.6490E+02	0.0000E+00
6	0.4504E+03	-0.2599E+03	0.1036E+00	0.6488E+02	0.0000E+00

TRIAL SOLUTION

BRANCH	DELP (PSI)	FLOWRATE (LBM/SEC)
12	0.0000	0.0966
23	0.0000	0.0966
34	0.0000	0.0966
45	0.0000	0.0966
56	0.0000	0.0966
67	0.0000	0.0966

ISTEP = 1 TAU = 0.20000E-01

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
1	0.5000E+03	-0.2600E+03	0.0000E+00	0.6499E+02	0.0000E+00
7	0.4500E+03	-0.2600E+03	0.0000E+00	0.6491E+02	0.0000E+00

SOLUTION

INTERNAL NODES

NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.4831E+03	-0.2600E+03	0.1111E+00	0.6497E+02	0.2657E+01	0.0000E+00
3	0.4724E+03	-0.2600E+03	0.1087E+00	0.6494E+02	0.1771E+01	0.0000E+00
4	0.4639E+03	-0.2599E+03	0.1067E+00	0.6492E+02	0.1771E+01	0.0000E+00
5	0.4644E+03	-0.2599E+03	0.1068E+00	0.6491E+02	0.1770E+01	0.0000E+00
6	0.4993E+03	-0.2597E+03	0.1147E+00	0.6493E+02	0.8853E+00	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
2	0.7705E+02	0.1525E+01	0.8398E-04	0.1819E-04	0.4174E+00	0.2026E+01
3	0.7705E+02	0.1525E+01	0.8386E-04	0.1818E-04	0.4177E+00	0.2028E+01
4	0.7705E+02	0.1525E+01	0.8374E-04	0.1817E-04	0.4179E+00	0.2029E+01

5	0.7708E+02	0.1525E+01	0.8367E-04	0.1816E-04	0.4179E+00	0.2030E+01
6	0.7721E+02	0.1525E+01	0.8376E-04	0.1817E-04	0.4174E+00	0.2028E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/ (LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO. BTU/(R-SEC)	ENTROPY GEN. LBF-FT/SEC	LOST WORK
12	0.152E+06	0.169E+02	0.999E-01	0.451E+01	0.726E+05	0.569E-02	0.150E-04	0.233E+01
23	0.153E+06	0.108E+02	0.968E-01	0.437E+01	0.705E+05	0.552E-02	0.138E-04	0.214E+01
34	0.153E+06	0.847E+01	0.960E-01	0.434E+01	0.700E+05	0.547E-02	0.135E-04	0.209E+01
45	0.155E+06	-0.464E+00	0.927E-01	0.419E+01	0.677E+05	0.528E-02	0.122E-04	0.190E+01
56	0.162E+06	-0.350E+02	0.748E-01	0.338E+01	0.547E+05	0.426E-02	0.673E-05	0.105E+01
67	0.513E+05	0.493E+02	0.409E-01	0.553E+01	0.516E+05	0.697E-02	0.347E-06	0.539E-01

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 283 ITERATIONS
TAU = 2.000000000000000E-002 ISTEP = 1

:
:
:
:

ISTEP = 25 TAU = 0.50000E+00

BOUNDARY NODES

NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
1	0.5000E+03	-0.2600E+03	0.0000E+00	0.6499E+02	0.0000E+00
7	0.4500E+03	-0.2600E+03	0.0000E+00	0.6491E+02	0.0000E+00

SOLUTION

INTERNAL NODES

NODE	P (PSI)	TF (F)	Z (LBM/FT^3)	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.4830E+03	-0.2600E+03	0.1111E+00	0.6497E+02	0.2658E+01	0.0000E+00
3	0.4549E+03	-0.2601E+03	0.1047E+00	0.6493E+02	0.1771E+01	0.0000E+00
4	0.4353E+03	-0.2601E+03	0.1003E+00	0.6490E+02	0.1770E+01	0.0000E+00
5	0.4216E+03	-0.2601E+03	0.9715E-01	0.6488E+02	0.1769E+01	0.0000E+00
6	0.4180E+03	-0.2600E+03	0.9631E-01	0.6486E+02	0.8844E+00	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
2	0.7704E+02	0.1525E+01	0.8400E-04	0.1819E-04	0.4174E+00	0.2026E+01
3	0.7699E+02	0.1525E+01	0.8379E-04	0.1817E-04	0.4180E+00	0.2029E+01
4	0.7696E+02	0.1525E+01	0.8363E-04	0.1816E-04	0.4184E+00	0.2031E+01
5	0.7695E+02	0.1525E+01	0.8349E-04	0.1815E-04	0.4187E+00	0.2032E+01
6	0.7697E+02	0.1525E+01	0.8340E-04	0.1814E-04	0.4188E+00	0.2033E+01

BRANCHES

BRANCH	KFACTOR (LBF-S^2/ (LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.203E+06	0.170E+02	-0.285E-01	-0.129E+01	0.208E+05	0.163E-02	0.467E-06	0.725E-01
23	0.215E+06	0.281E+02	-0.225E-01	-0.102E+01	0.164E+05	0.128E-02	0.243E-06	0.377E-01
34	0.235E+06	0.196E+02	-0.159E-01	-0.717E+00	0.116E+05	0.904E-03	0.931E-07	0.145E-01
45	0.274E+06	0.137E+02	-0.903E-02	-0.408E+00	0.661E+04	0.514E-03	0.200E-07	0.310E-02
56	0.237E+06	0.365E+01	-0.292E-02	-0.132E+00	0.214E+04	0.166E-03	0.583E-09	0.906E-04
67	0.138E+34	-0.320E+02	-0.111E-11	-0.246E+05	0.179E+02	0.309E+02	0.186E-09	0.288E-04

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 101 ITERATIONS
TAU = 0.500000000000000 ISTEP = 25

:
:
:
:

ISTEP = 50 TAU = 0.10000E+01

BOUNDARY NODES					
NODE	P (PSI)	TF (F)	Z (COMP)	RHO (LBM/FT^3)	QUALITY
1	0.5000E+03	-0.2600E+03	0.0000E+00	0.6499E+02	0.0000E+00
7	0.4500E+03	-0.2600E+03	0.0000E+00	0.6491E+02	0.0000E+00

SOLUTION INTERNAL NODES						
NODE	P (PSI)	TF (F)	Z	RHO (LBM/FT^3)	EM (LBM)	QUALITY
2	0.5083E+03	-0.2599E+03	0.1168E+00	0.6499E+02	0.2658E+01	0.0000E+00
3	0.5192E+03	-0.2598E+03	0.1193E+00	0.6499E+02	0.1772E+01	0.0000E+00
4	0.5261E+03	-0.2597E+03	0.1208E+00	0.6498E+02	0.1772E+01	0.0000E+00
5	0.5303E+03	-0.2596E+03	0.1217E+00	0.6497E+02	0.1772E+01	0.0000E+00
6	0.5313E+03	-0.2596E+03	0.1220E+00	0.6496E+02	0.8856E+00	0.0000E+00

NODE	H BTU/LB	ENTROPY BTU/LB-R	EMU LBM/FT-SEC	COND BTU/FT-S-R	CP BTU/LB-R	GAMA
2	0.7711E+02	0.1525E+01	0.8413E-04	0.1820E-04	0.4170E+00	0.2024E+01
3	0.7717E+02	0.1525E+01	0.8411E-04	0.1820E-04	0.4168E+00	0.2024E+01
4	0.7722E+02	0.1525E+01	0.8406E-04	0.1819E-04	0.4168E+00	0.2025E+01
5	0.7726E+02	0.1525E+01	0.8401E-04	0.1819E-04	0.4167E+00	0.2025E+01
6	0.7729E+02	0.1525E+01	0.8394E-04	0.1819E-04	0.4168E+00	0.2025E+01

BRANCHES								
BRANCH	KFACTOR (LBF-S^2/ (LBM-FT)^2)	DELP (PSI)	FLOW RATE (LBM/SEC)	VELOCITY (FT/SEC)	REYN. NO.	MACH NO.	ENTROPY GEN. BTU/(R-SEC)	LOST WORK LBF-FT/SEC
12	0.189E+06	-0.832E+01	-0.378E-01	-0.171E+01	0.275E+05	0.215E-02	0.101E-05	0.157E+00
23	0.195E+06	-0.109E+02	-0.334E-01	-0.151E+01	0.243E+05	0.190E-02	0.720E-06	0.112E+00
34	0.207E+06	-0.692E+01	-0.263E-01	-0.119E+01	0.191E+05	0.150E-02	0.372E-06	0.578E-01
45	0.232E+06	-0.423E+01	-0.167E-01	-0.755E+00	0.122E+05	0.952E-03	0.107E-06	0.167E-01
56	0.312E+06	-0.104E+01	-0.569E-02	-0.257E+00	0.415E+04	0.324E-03	0.570E-08	0.887E-03
67	0.138E+34	0.814E+02	-0.111E-11	-0.246E+05	0.179E+02	0.310E+02	0.186E-09	0.288E-04

SOLUTION SATISFIED CONVERGENCE CRITERION OF 0.100E-03 IN 128 ITERATIONS
 TAU = 1.00000000000000 ISTEP = 50

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 TIME OF ANALYSIS WAS 27.5996864000000 SECS



APPENDIX P—LIST OF PUBLICATIONS WHERE GFSSP HAS BEEN USED

	Title	Author(s)	Conference/Journal
1	A General Fluid System Simulation Program to Model Secondary Flows in Turbomachinery	Alok Majumdar Katherine Van Hooser	31 st AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, July 10-12, 1995, San Diego, CA, AIAA 95-2969
2	Mathematical Modeling of Free Convective Flows for Evaluating Propellant Conditioning Concepts	Alok Majumdar John Bailey Kimberly Holt Susan Turner	32 nd AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, July 1-3, 1996, Lake Buena Vista, FL, AIAA 96-3117
3	A Generalized Fluid System Simulation Program to Model Flow Distribution in Fluid Networks	Alok Majumdar John Bailey Biplab Sarkar	33 rd AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, July 6-9, 1997, Seattle, WA, AIAA 97-3225
4	Numerical Prediction of Pressure Distribution Along the Front and Back Face of a Rotating Disc With and Without Blades	Paul Schallhorn Alok Majumdar	33 rd AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, July 6-9, 1997, Seattle, WA, AIAA 97-3098
5	Flow Network Analyses of Cryogenic Hydrogen Propellant Storage and Feed Systems	Douglas Richards Daniel Vonderwell	33 rd AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, July 6-9, 1997, Seattle, WA, AIAA 97-3223
6	A Generalized Fluid System Simulation Program to Model Flow Distribution in Fluid Networks	Alok Majumdar John Bailey Paul Schallhorn Todd Steadman	34 th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, July 13-15, 1998, Cleveland, OH, AIAA 98-3682
7	Flow Simulation in Secondary Flow Passages of a Rocket Engine Turbopump	Paul Schallhorn Alok Majumdar Katherine Van Hooser Matthew Marsh	34 th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, July 13-15, 1998, Cleveland, OH, AIAA 98-3684
8	A Novel Approach for Modeling Long Bearing Squeeze Film Damper Performance	Paul Schallhorn David Elrod David Goggin Alok Majumdar	34 th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, July 13-15, 1998, Cleveland, OH, AIAA 98-3684
9	Unstructured Finite Volume Computational Thermo-Fluid Dynamics Method for Multi-Disciplinary Analysis and Design Optimization	Alok Majumdar Paul Schallhorn	7 th AIAA/USAF/NASA/ISSMO Symposium on Multidisciplinary Analysis and Optimization, September 2-4, 1998, St. Louis, MO AIAA 98-4810
10	Numerical Modeling of Pressurization of a Propellant Tank	Alok Majumdar Todd Steadman	37 th AIAA Aerospace Sciences Meeting Conference and Exhibit, January 11-14, 1999, Reno, NV AIAA 99-0879 To be published in AIAA Journal of Propulsion and Power, November-December 2000

	Title	Author(s)	Conference/Journal
11	A Second Law Based Unstructured Finite Volume Procedure for Generalized Flow Simulation	Alok Majumdar	37 th AIAA Aerospace Sciences Meeting Conference and Exhibit, January 11-14, 1999, Reno, NV AIAA 99-0934
12	Numerical Prediction of Transient Axial Thrust and Internal Flows in a Rocket Engine Turbopump	Katherine Van Hooser John Bailey Alok Majumdar	35 th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, June 21, 1999, Los Angeles, CA, AIAA 99-2189
13	Numerical Modeling of Helium Pressurization System of Propulsion Test Article (PTA)	Todd Steadman Alok Majumdar Kimberly Holt	Thermal & Fluids Analysis Workshop, September 13-17, 1999, Huntsville, AL
14	A Steady State and Quasi-Steady Interface Between the Generalized Fluid System Simulation Program and the SINDA/G Thermal Analysis Program	Paul Schallhorn Alok Majumdar Bruce Tiller	Thermal & Fluids Analysis Workshop, September 13-17, 1999, Huntsville, AL
15	Interfacing a General Purpose Fluid Network Flow Program with the Sinda/G Thermal Analysis Program	Paul Schallhorn Dan Popok	SAE Paper No. 1999-01-2162
16	An Unsteady Long Bearing Squeeze Film Damper Model – Part I: Circular Centered Orbits	Paul Schallhorn David Elrod David Goggin Alok Majumdar	38 th AIAA Aerospace Sciences Meeting Conference and Exhibit, January 11-14, 1999, Reno, NV AIAA 2000-0352
17	An Unsteady Long Bearing Squeeze Film Damper Model – Part II: Statically Eccentric Operation	Paul Schallhorn David Elrod David Goggin Alok Majumdar	38 th AIAA Aerospace Sciences Meeting Conference and Exhibit, January 11-14, 1999, Reno, NV AIAA 2000-0353
18	A Fluid Circuit Model for Long Bearing Squeeze Film Damper Rotordynamics	Paul Schallhorn David Elrod David Goggin Alok Majumdar	AIAA Journal of Propulsion and Power, Vol. 16, No. 5, pp 777-780, Sept – Oct 2000
19	Unsteady Analysis of the Fluid Film Forces in a Long Bearing Squeeze Film Damper	Paul Schallhorn	Ph. D. Dissertation, University of Alabama in Huntsville, 1998
20	Numerical Modeling and Test Data Comparison of Propulsion Test Article Helium Pressurization System	Kimberly Holt Alok Majumdar Todd Steadman Ali Hedayat	36 th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, July 16-19, 2000, Huntsville, AL, AIAA 2000-3719
21	Numerical Modeling of Drying Residual RP-1 in Rocket Engines	Alok Majumdar Robert Polsgrove Bruce Tiller	Thermal & Fluids Analysis Workshop, August 21-25, 2000, Cleveland, OH
22	Incorporation of Condensation Heat transfer Model into a Flow Network Code	Miranda Anthony. Alok Majumdar	Thermal & Fluids Analysis Workshop, September 10-14, 2001, Huntsville, Alabama.

	Title	Author(s)	Conference/Journal
23	Discharge Characteristics of the International Space Station (Ise) Portable Fire Extinguisher (Pfe) and the effect on Closed Volumes	Charles E Martin Paul Schallhorn Paul Wieland	SAE Paper No. 2001-01-2316
24.	Modeling of Chill Down in Cryogenic Transfer Lines	M. Cross A.K. Majumdar J. C. Bennett Jr. R. B. Malla	Journal of Spacecraft and Rockets, Vol. 39, No. 2, 2002, pp 284-289.
25	Numerical modeling of cavitating venturi – a flow control element of propulsion system	Alok Majumdar	Thermal & Fluids Analysis Workshop, August 12-16, 2002, Houston, TX
26	Numerical Modeling of Fluid Transient by a Finite Volume Procedure for Rocket Propulsion Systems	Alok Majumdar Robin Flachbart	Proceedings of ASME FEDSM'03, 4 th ASME/JSME Joint Fluids Engineering Conference, Paper No. FEDSM2003-45275, Honolulu, Hawaii, USA, July 6-10, 2003
27	Numerical Modeling of Thermofluid Transients During Chillydown of Cryogenic Transfer Lines	Alok Majumdar Todd Steadman	33 rd International Conference on Environmental Systems (ICES), Paper No. 2003-01-2662, Vancouver, Canada, July 6-10, 2003.
28	Numerical Modeling of Unsteady Thermofluid Dynamics in Cryogenic Systems	Alok Majumdar	Thermal & Fluids Analysis Workshop, August 18-22, 2003, Hampton, Virginia
29	A Novel Approach for Modeling Chemical Reaction in Generalized Fluid System Simulation Program	Mehmet Sozen Alok Majumdar	39 th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, July 20-23, 2003, Huntsville, AL, AIAA 2003-4467
30	Numerical Modeling of Conjugate Heat Transfer in Fluid Network	Alok Majumdar	Thermal & Fluids Analysis Workshop, August 30- September 3, 2004, Jet Propulsion Laboratory, Pasadena, California
31	Numerical Modeling of Flow Distribution in Microfluidics Systems	Alok Majumdar Helen Cole C. P. Chen	Proceedings of Forum on Microfluidics Devices and Systems, ASME Fluids Engineering Conference, Paper No. FEDSM 2005-77378, June 19-23, 2005, Houston, Texas
32	Development and Implementation of Non-Newtonian Rheology into the Generalized Fluid System Simulation Program (GFSSP)	Roberto Di Salvo Stelu Deaconn Alok Majumdar	42 nd AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, July 9-12, 2006, Sacramento, CA, AIAA 2006-
33	Microfluidic System Simulation including the Electro-Viscous Effect	Eileen Rojas C. P. Chen Alok Majumdar	Integration and Commercialization of Macro and Nano Systems, ASME International Conference, Paper No. MNC2007-21295, Sanya, Hainan China, Jan 10-13, 2007